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## Notes on Three Irrigation Projects in the Punjab, India.

By A. B. SEGUR.*

During a recent trip returning from the Philippine Islands to this country, the writer spent considerable time in visiting the many irrigation works for which India is so justly famous. He was particularly impressed with the extent and magnitude of the projects in that portion of the Hindustan peninsula lying to the north end known as the Punjab.† Through the courtesy of the government engineers there he was enabled to make a very thorough inspection of the whole district and to collect a quantity of information, some of which is set down in these notes for the benefit of American engineers interested in irrigation.

Of the many great irrigation projects in the United Provinces, of India, and the Punjab, commanding a total of nearly 12,000,000 acres, perhaps the three most interesting are the Western Jumna, the Lower Chenab, and the great triple project (including the Upper Jhelum, the Upper Chenab and the Lower Bari Doab canals, irrigating the Upper Jech, the Upper Rechna, and the Lower Bari Doabs, respectively. The Western Jumna is interesting chiefly from the historical standpoint; the Lower Chenab is interesting because it is the largest and best irrigation project in operation in India and probably in existence; and the "triple project" is interesting because it is the largest and boldest irrigation project under construction in the world. To be sure the various other irrigation projects in the Punjab are noteworthy and most of them represented the combined experience of their predecessors at the time they were built, but this article will deal only with a few features on these three projects.

### General Conditions in the Punjab.

Perhaps it might be well to give here a few of the general conditions that have obtained in the Punjab, under which the engineers have worked. Under the old native regime all land and land rights were the property of the state, the occupants being simply tenants of the state. When the East India Company conquered the Sikhs and other native tribes, these rights were directly to the company and after the mutiny they were transferred to the English crown. As no one sought land in this desert before water was brought into the country there was no such thing as private ownership of land. When irrigation was proposed, the Canal Act was passed. This Act gives all water rights to the government; gives the government the right to construct any canals it may see fit, to finance them by the flotation of loans to be paid off by the sale or lease of the land to be benefited, and the sale of water for the land. It gives the engineering corps the power to punish all offenses against the Canal Act and the power to settle all disputes under the Act, and constitutes each division engineer a second class magistrate upon passing certain examinations.

Labor is very cheap, but generally of an inferior quality, although the Pootans or travelling hill tribes make very good laborers. The following is an average scale, subject to great alteration:

| | |
|---|---|
| Laborers | 8—12 cts. per day |
| Masons | 15—22 cts. per day |
| Foremen | 25—45 cts. per day |
| Clerks | $3—$5 per month |

The petty contract is of such long standing that it would be next to impossible to root it out. The contractors are generally tribal or village chiefs who can command a large amount of labor. They are paid by the cubic foot and furnish nothing except the labor. The Indian has not as yet advanced to the point where he will execute a hard and fast contract. The completion of a job is very likely to be one series of extortions on the part of the contractor from the engineer, and a series of changes of contractors and of terms by the engineer. Dishonesty among the native subordinates is very difficult to prevent.

The rainfall on the Western Jumna averages about 18 ins. per year while that of the Chenab and Bari Boab districts averages 10 ins. per year. There are two distinct seasons, the wet and the dry. Fortunately the dry season is the cool season when the temperature is in the neighborhood of 50° F. The sun makes work impossible during the hot season when the thermometer rises to 135° F. in some sections. The ground is quite fertile. The wet or rainy season crop is millet, pulse, rice, and fruit. The dry season crop consists of cotton, cereals, vegetables, hay, sugar and fruits. As the work was undertaken primarily as a famine measure there are always enough people to populate the irrigated tracts. The Hindus from the southern districts generally understand dry farming and will go from October 14 to December 25 and mature a crop without water provided they have a good rain at the beginning and end of that time. The Mohammedans, on the other hand, were, as a general rule, nomads in the country before irrigation was taken up and, consequently, they do not understand the use of water so well. The water duty is maintained at from 600 acres per cusec* for the dry season crop, under favorable conditions, to 70 acres per cusec for the wet season crop, under less favorable conditions. In accordance with their habits before British occupation, the natives live in villages and go back and forth to their fields. Isolated dwellings are almost a rarity. There is practically no coal in the country with which to make cement and imported cement is very expensive on account of the great distances. There is a large amount of clay at nearly every point; large beds of nearly pure limestone are found at more or less widely separated spots, all over the Punjab and Kunker lime, a caked lime silicate, also exists in large quantities.

PANORAMIC VIEW OF BAYS 4, 5 AND 6 MARALA WEIR, UPPER CHENAB CANAL, PUNJAB, INDIA.

### The Western Jumna Project.

The Western Jumna, in point of time, comes first, having been built by Shah Jahan in the year 1640, to bring water to the baths of his palace in Delhi. The use of the water for irrigation was, seemingly, only a secondary consideration. This canal took out at Jagandhum and followed more or less the high drainage lines from Jagandhum to Delhi. Naturally, as the irrigation belt on this sort of a canal was very narrow and the irrigation had to be done mostly by lifts, it did not serve the needs of the country very well, so after the English Government was established, the canals were thoroughly remodeled, made to follow the ridges, and to serve as navigation channels connecting the Jumna

*Angola, Indiana. Late of the Philippine Engineering Service.

†For map and description of the Punjab and its irrigation projects, see the article by Mr. W. G. Bligh, on p. 589 of this issue.—Ed.

*Cubic feet per second, hereinafter termed "sec.-ft."

with the Ganges. However, as the old right of way was very valuable, it was used whenever possible. Large embankments were used to carry the canal over depressions. These improvements greatly widened the irrigation belt and established free flow irrigation.

As the ground is very flat here, there was no very great slope given to the canals; in fact, for three miles before reaching Delhi the canal bed is level. The velocity being low, the fine silt is found to settle in the bed and on the banks of the canal, thereby reducing the percolation loss to a very low figure. But, on the other hand, the evaporation loss is considerable, and weeds growing in the bottom give much trouble, especially over the flat portion. Here the weeds have to be cut by hand on an average of once in two months.

Small vertical lift screw gates are used at the branches, but it is the general policy of the canal authorities to set these gates so as to give each private ditch its proper share of water and to allow these gates to remain open except in the case of accident, drouth or flood. The gates are kept well oiled, however, and attendants are kept to watch them. The bridges are mostly massive stone or brick arches, or, in some cases, brick arches faced with stone. In many cases the old Mogul pointed stone arches are in place. These are unusually massive. The structure as a whole forms a strange admixture of the new and the old.

The long use of irrigation in the district has brought the subsurface water level to within a few feet of the surface. This condition makes it doubtful, in some cases, whether irrigation is a necessity or not. There is a great deal of trouble with malaria and one frequently hears the charge that irrigation takes the life out of the people.

The experience of the engineers of the Punjab seems to be that boat navigation on irrigation canals does not pay where there is good railway transportation. The only traffic that paid a profit on the Western Jumna canal in 1908 was a timber rafting traffic above Abdullapur. This showed a profit of $16,000 while the boat traffic showed an actual loss of $1,000. Wide navigation canals take long and high railway and highway bridges. Since they cannot be covered, they make it very inconvenient when business blocks expand to the bank of the stream. Consequently the canals are being filled in to a width just sufficient to carry the irrigation water and the extra ground sold as business sites at an enormous profit to the Government. Bridges can thereby be lowered allowing a better gradient for the roadway.

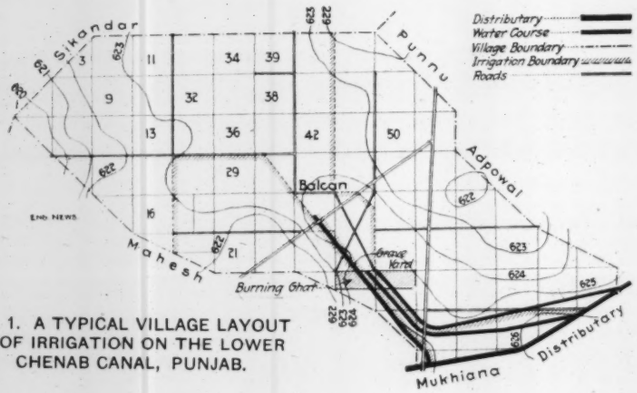


FIG. 1. A TYPICAL VILLAGE LAYOUT OF IRRIGATION ON THE LOWER CHENAB CANAL, PUNJAB.

### The Lower Chenab Canal.

The Lower Chenab canal has had the advantage of the accumulated experience of the Punjab engineers on the Western Jumna, Sirhind, Bari Doab, and the other older canals; and it is probably the most up to date as well as most perfect working canal in India. The Lower Chenab was originally built as an inundation canal, watering only a very small territory on the left bank of the Chenab river below Khanki. The inundation, however, did not give sufficient water for even the small territory commanded, consequently a weir was proposed. The weir was found to be too expensive for the territory benefited, so the scheme was enlarged to take in all the dry season flow, and to water all the flat land between the Ravi and Chenab rivers.

The river banks diverge just below Khanki, forming a bay four miles long and from two and one half to three miles wide. The fall in this bay was ten feet. The dry season channel was through the middle of the bay, but during the wet season, the rising water widened out and turned the bay into a lake. At the lower end of the bay the banks are low for several miles down stream. At Khanki the left bank is high and well defined and the right bank is low and gradually rising. In fact the first point at which two well-defined banks could have been obtained was about 20 miles up the river.

THE KHANKI WEIR.—The head works of the inundation canal were at the lower end of the bay above mentioned, but this did not give the proper command. The headworks therefore had to be moved. To move the headworks 20 miles up stream would have necessitated a large expense for extra canal; and money for irrigation purposes was not easily obtained at that time. Consequently, the headworks site was moved to the head of the bay. A weir 4,000 ft. long was built with the intake on the left bank of the river. The weir was divided into bays of 300 ft. by means of draw walls extending about 250 ft. upstream and about 50 ft. down stream. These draw walls were built of masonry on a foundation of wells and protected at the ends by heavy stone aprons. They were built about five feet above the extreme flood line. The purpose of these draw walls was twofold; to provide an easy means of operating the weir gates and to prevent scour along the face of the weir. The up-stream floor of the weir including the protecting apron extended about two-thirds the length of these walls and the downstream floor, including the protecting apron, extended about 100 ft. below the downstream face of the weir. In the floor design, a hydraulic gradient of 1.6 was assumed with no tension allowed in the masonry. Four lines of wells were used, one under the upstream end of the weir floor, one under each side of the weir proper and one under the down stream end of the weir floor. The wells were sunk deep enough to be well below the maximum scour, and to be based on a good bearing strata. They are of the usual brick type used on English work.

Since experience on the Sirhind had taught the engineers the absolute necessity of provision for sluicing in front of the intake, a forebay was formed of the first bay from the intake by lengthening the first draw wall to 300 ft., and greatly strengthening it. At the end of the weir, parallel to this draw wall was built the intake, consisting of twelve bays of 25 ft. The general construction of the intake was of concrete. Heavy wooden gates, sliding in grooves, rest on the foundation. As the water rises, flash boards are dropped on top these gates, the top of the boards being kept high enough to take in the full canal supply from the top film of water. In the weir proper, in the first bay, are built the sluice gates, divided by piers into 12 spans of 25 ft. These are lifted by means of a traveling overhead winch. During the low water a continuous current flows along the weir toward the intake. The heavy silt falls in front of the intake and is sluiced out by the first flood when the sluices are opened.

On the right bank of the river a large embankment of earth, or a spur, extended from the weir at right angles to the river for three miles inland to higher ground and then five miles upstream. At the weir this spur is protected by an earth hammer head, reinforced by heavy stone aprons, extending 200 ft. upstream and 600 ft. down stream. The high canal banks prevent the river flanking the weir on the left bank.

This weir proved satisfactory until the high floods of two years ago and then the unexpected happened. The river instead of going straight across the bay took a winding course. A silt laden flood came down and its velocity was so far reduced in spreading out over the lake that it silted up the stream almost to a level with the top of the weir. The sluice gates refused to work; the river above the weir was heavily silted up and heavy silt was carried into the canal over the top of the intake gates.

This was corrected in the following manner. About 1,400 ft. downstream of the weir two embankments of earth were built, one on each side of the river, their ends being a trifle over 4,000 ft. apart, extending from the desired waters edge to the higher ground. Each of these was protected by a small masonry hammer head which was protected in turn by a stone apron. Already the silt in the center of the river is washing away; 10 ft. of silt has deposited between the parallel embankments, the weir protection bank and the second spur, and the next flood season will see the undersluices in perfect working order again. Upstream of the former intake, and contiguous to it, a second intake consisting of eight spans is being built. In this new work flash boards have been abandoned for a double sliding gate. A stone crib and earth cofferdam was built around the site of this new intake and the work is being done in the dry. This addition will serve a double purpose. It will serve as a duplicate intake in case of accident to the first one and it will provide for a thinner film of water, thus excluding heavy silt.

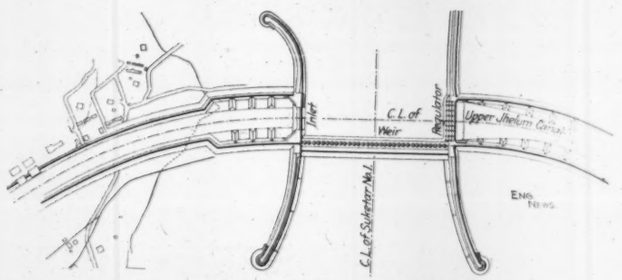


FIG. 2. THE LEVEL CROSSING OF THE UPPER CHENAB CANAL OVER THE SUKATER RIVER.

No effort is being made to make the gates of the weir engage rigidly. A working clearance is maintained and the crevices stopped with grass, etc. When necessary, earth cofferdams are built between the draw walls in order to repair the gates in the dry.

Communication is maintained between the two ends of the weir by means of an overhanging cable and a car. This cable is supported by a watch tower on top of each draw wall. Formerly the cable was fastened rigidly to each tower, but this gave a great deal of trouble on account of the stretching of the cable and so now after many experiments the following arrangement is used. At one end, the cable is rigidly fastened to a tower. At the other end, the rope passes over a tower; fastens to a block and tackle arrangement of smaller cable; which in turn is fastened to a weight hung in a well. This maintains a constant tension in the cable. The cable is supported by each of the watch towers but is not fastened to any of them.

When the cable stretches far enough to allow the weight to sink to the bottom of the well, the tackle is pulled up, bringing the weight to the top again. A cable fastened to a dead man and to the well pulley overcomes the overturning moment due to the weight and the cable. When the cable has stretched far enough to bring the blocks of the tackle together, the tackle is hitched at its full length again and the extra cable cut off. This arrangement doubles the life of the cable and is by far the most satisfactory arrangement yet found.

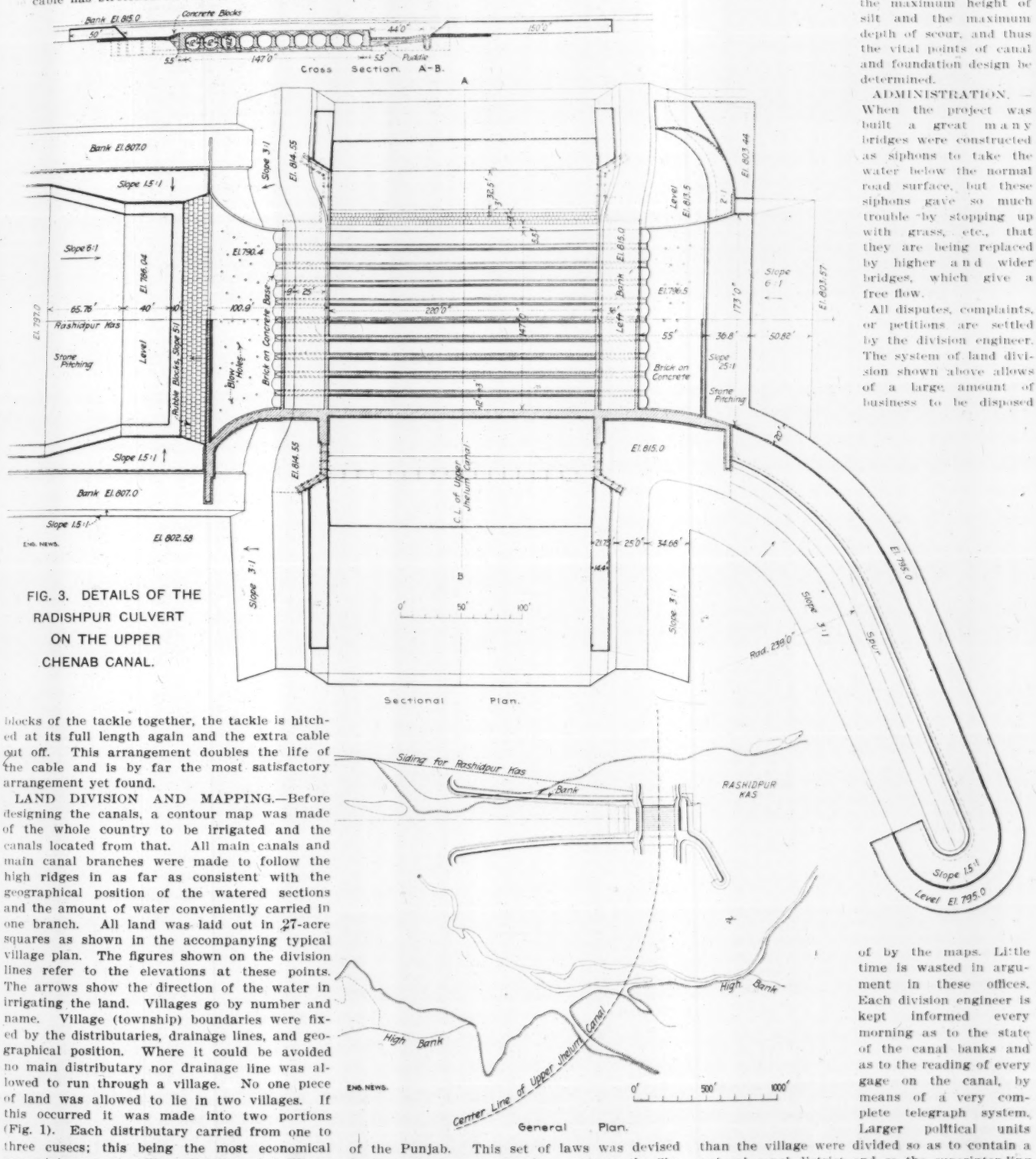


FIG. 3. DETAILS OF THE RADISHPUR CULVERT ON THE UPPER CHENAB CANAL.

LAND DIVISION AND MAPPING.—Before designing the canals, a contour map was made of the whole country to be irrigated and the canals located from that. All main canals and main canal branches were made to follow the high ridges in as far as consistent with the geographical position of the watered sections and the amount of water conveniently carried in one branch. All land was laid out in 27-acre squares as shown in the accompanying typical village plan. The figures shown on the division lines refer to the elevations at these points. The arrows show the direction of the water in irrigating the land. Villages go by number and name. Village (township) boundaries were fixed by the distributaries, drainage lines, and geographical position. Where it could be avoided no main distributary nor drainage line was allowed to run through a village. No one piece of land was allowed to lie in two villages. If this occurred it was made into two portions (Fig. 1). Each distributary carried from one to three cusecs; this being the most economical amount to carry in village distributaries. Whenever possible, private distributaries were made to flow along the boundaries of the individual squares, but where this was impracticable it was taken diagonally across. Water was taken out on the boundaries. Along all natural drainage courses a strip of land 200 ft. wide was reserved as a drainage line. When the subsurface water level, which is raising at the rate of two feet per year, rises to within a few feet of the surface, drainage lines can be built without excessive expense. All road lines were laid off along with the irrigation survey. Main roads were run direct between villages and side roads were made to run along boundaries.

SILT DETERMINATIONS.—Kennedy's laws of silt seem to determine most of the designs of the Punjab. This set of laws was devised by Kennedy from observations made on the Sirhind canal and has been found to hold good on practically all of the canals of the Punjah.

The laws are:

$V_o$ = the critical velocity or the velocity of no silt nor no scour.

V = any velocity.

d = the depth of the stream.

p = the silt carried at $V_o$.

x = the silt carried at any other velocity.

then

$$V_o = 0.84\, d^{0.64}$$

$$p - x = p\left[1 - \left(\frac{V}{V_o}\right)^{5/2}\right] \text{ or } x = p\left(\frac{V_o}{V}\right)^{5/2}$$

It is quite evident that from these two equations one may work out an ideal canal section, the maximum height of silt and the maximum depth of scour, and thus the vital points of canal and foundation design be determined.

ADMINISTRATION.—When the project was built a great many bridges were constructed as siphons to take the water below the normal road surface, but these siphons gave so much trouble by stopping up with grass, etc., that they are being replaced by higher and wider bridges, which give a free flow.

All disputes, complaints, or petitions are settled by the division engineer. The system of land division shown above allows of a large amount of business to be disposed of by the maps. Little time is wasted in argument in these offices. Each division engineer is kept informed every morning as to the state of the canal banks and as to the reading of every gage on the canal, by means of a very complete telegraph system. Larger political units than the village were divided so as to contain a natural canal district and so the superintending engineer can deal with a political unit at the same time he gives orders to his division engineers.

Wastage is charged for heavily. Great care is taken to reduce the amount of standing water along the canal to a minimum as measurements taken here tend to show that an area of standing water wastes water enough to irrigate an area 28 times as great.

### The Triple Project.

The "triple project" represents not only the greatest irrigation project in the world, but also the greatest deference ever shown by a stronger power to a weaker one, in the way of general improvements. About 1900, a plan was submitted by the Public Works Department, and approved by the central government at Calcutta, providing for the watering of the Lower Bari Doab district, that district lying between the Ravi and the Sutlej rivers, from the Sutlej river. This meant the absorption of several old irrigation canals operated on the left bank of the Sutlej river, but the total cost would have been but little over $1,500,000.

When construction was about to begin, a retired chief engineer of the Punjab pointed out that if this scheme was carried out, Rajputana, an independent state south of the Punjab, would be forever deprived of irrigation. The Sutlej rises in British territory and runs for its full course in British territory and yet the argument had weight enough that this plan was abandoned, and an entirely new plan drawn up by which the surplus water from the Jhelum river was taken out at Mangla (at point marked "New Weir" on map on p. 589), and carried around the foothills of the Himalayas and emptied into the Chenab river at Marala, 30 miles up stream of Khanki; and carried across the Ravi river to the lower Bari Doab. This is called the "Upper Chenab Canal" on the map. The original estimate of this project was $26,500,000, but the plan was adopted in preference to the first scheme.

The Jhelum river leaves the mountains at Mangla in the form of a large letter S. At the lower end of this S is a large bar stretching across the river, consisting of shale, rock, and sand, which has changed neither position nor size in the last ten years. This serves as a weir. Extending from this bar up to the beginning of the S, the river is about 35 ft. deep.

The regulator is placed on a high bank at the lower curve of the S. The foundation is solid rock and clay on a heavy dip. The bottom of the gate is 25 ft. below the low water surface. The gates are in three stages so that the top water can be drawn off at all times. The natural weir feature of this headworks, probably ranks it as the most unique large headworks in the world.

For the first 40 miles the most striking features of this work are the heavy work and the large number of cross drainages encountered. At the headworks the canal carrying about 9,000 sec.-ft. goes through a cut varying from 108 ft. at the intake to zero three miles below. Cross-drainages are passed in two ways, i. e., level crossings and culverts. It would be impossible in the short space allotted to this article to describe in detail each of the works and the principles used in their design and so one large culvert and one large level crossing only will be described.

LEVEL CROSSING, SUKATER NO. 1.—This torrent of 140,000 sec.-ft. emerges from the hills in the 16th mile and crosses the canal on its way to the Jhelum river. At the point of crossing it is about ½ mile wide. Running close to the Sukater in the hills and crossing the canal in the 17th mile is the Jabbi torrent of 8,000 sec.-ft. The Jabbi is connected with the Sukater. An earth dam is thrown across the Jabbi and about 1,000 ft. above this dam an open cut is made from the Jabbi to the Sukater. The slope of each torrent is in the neighborhood of 1:20. The accompanying diagram (Fig. 2) shows how this was handled at the canal. The torrent flows over a weir consisting of 33 bays of 40 ft. span. This weir is fitted with falling gates which are dropped in time of flood and raised at other times. At the inlet and outlet of the canal, are placed control works or gates. The water in ordinary times runs through the inlet into the small pond formed by the large weir, the two control works, and the slope of the torrent and then flows out through the outlet control works. The pond thereby forms a sort of settling basin. In flood, the gates of the large weir are dropped, the flood is passed; and the basin is scoured out. The water entering the canal by the outlet is carefully controlled and in time of extreme flood the Mangla headworks, the inlet and outlet works of both Sukaters are closed. Long guide banks extending from the control works well back toward the torrent banks contract the torrent to the width of the weir. These banks are paved and protected from under scour by Bell's bunds. The guide banks and the canal banks together thus form a sort of lake of still water, in time of flood, which silts up, thereby strengthening the canal banks. At the outlet of the canal as well as at the inlet, the canal is widened and cross walls of bamboo are built from the canal banks to the normal width of the canal. This serves two purposes. The water leaves the canal at a reduced velocity, thus giving less erosion on the weir. Between these cross walls the silt is deposited, thereby building up the banks. The banks are therefore strengthened both inside and outside of the canal at their weakest point. The floors of the weir, of the escape and of the intake are designed on the same principle as those of the Khanki weir. Beyond the canal the torrent is again widened out by means of the guide banks.

RADISHPUR CULVERT.—The most notable of the culverts is the Radishpur culvert (Fig. 3), now under construction. The canal level is 805, while that of the torrent bed is 803.6. It was considered necessary to place the top of the culvert at least 6 ins. below canal level, and it was not considered wise to sink the bottom more than 13 ft. below the torrent level. These conditions along with the discharge, 17,359 sec.-ft., and the torrent slope practically fixed the design to a barrel culvert of ten barrels. As the accompanying figure (Fig. 3) shows, the center of the culvert is below both the inlet and the outlet, thereby giving a tendency to silt during low floods, but the canal banks allow a head of 10 ft. above the top of the barrels, which seems to be enough to clean any silt that may gather. The culverts are of brick masonry. Unit stresses of 50 lbs. per sq. in. in compression and zero in tension are allowed.

Machinery is not used on this work in anything like the way it is used in the United States. Lifting machinery is a rarity. In some places, notably at Mangla, excavating machinery is used because of the time saved. Engines are used only on long hauls. A railway runs along the canal for general transportation. Lime and brick are made in large quantities along the line of the canal, but little machinery is used for this.

The masonry work is one of the most interesting features of this work. The lime deposits mentioned mixed, one part Kunker, one part fat lime, and two parts clay brick dust, all ground together, make an excellent hydraulic concrete or mortar.

MARALA WEIR.—About 48 miles dow[n] the canal goes around the point of the hills a[t] then crosses the country to Khanki. About 5[0] miles above Khanki, at Marala, an amount o[f] water equal to that put in at Khanki is taken o[ut]. For this, perhaps, the finest weir in the world [is] being constructed. It consists of eight bays of 10 ft. In general plan it is the same as the Khank[i] weir. On the right side of the river about on[e] mile from the low bank rises a high bluff. [On] the left side, the bank rises gradually. On [the] intake or left side a guide bank begins at [the] weir and extends three miles up stream to [a] higher ground. On the right bank a spur runs f[rom] the end of the weir to the high bluff. The [gen]eral plan of the floor is shown by the accom[pan]ying diagram. In contrast to the Khanki w[eir], the draw walls in this work are placed with t[he] short end upstream and the long end down str[eam].

During construction, the river could [not] well be passed through another channel, so [bays] 4, 5 and 6, counting from the intake side w[ere] built up full strength, but two feet below grad[e]. Then the river was passed through these thre[e] bays and bays 1-3 and 7-8 were built to strength and grade. This required one full working [sea]son. The next season the river was run through the completed bays and the extra two feet added to the three low bays.

The front page view shows bays 4, 5 and 6, taken from the downstream end of the cross wall, while a cofferdam was being built around the low bays and the water was being shut off.

Gates are used here to the entire exclusion of flashboards. Stoney gates are used in the sluices.

In the original plan the lower Bari Doab alone was commanded by this immense project, but later as work went on, other branch canals were planned until all the available land between Jhelum and the Lower Bari Doab is commanded. As stated above, the original estimate was $26,500,000, but contingencies have arisen, and changes and additions have been made until the last estimate was in the neighborhood of $40,000,000, and the percentage of profit expected reduced from 10% to 7% per annum. This project means the following quantities of work on the main canal and the main canal works:

| | |
|---|---|
| Excavation | 332,000,000 cu. yds. |
| Concrete | 5,200,000 cu. ft. |
| Brick work | 9,500,000 cu. ft. |
| Stone | 3,400,000 cu. ft. |
| Stone pitching | 9,000,000 cu. ft. |

Below is given a synopsis of the first 34 miles of the canal, showing, even in that short distance, the large number of cross drainages.

The writer wishes to express his appreciation to a great number of engineers on the various works to whom he is indebted for the information contained in this article, for their hospitality and kindness during his recent stay in India.

SYNOPSIS OF WORK ON UPPER CHENAB CANAL.

| Mile. | Type. | Name. | Sec.-ft. | Remarks. |
|---|---|---|---|---|
| 1 | Regulator. | Mangla. | 8,500 | Slope, 1:1250; 20 spans of 12 ft.; masonry, 800,000 cu. ft. |
| 1-3 | Cut. | Mangla. | .... | Bed width, 150 ft.; 182,500,000 cu. ft. |
| 6 | Regulator. | ..... | 8,500 | 14 spans of 20 ft.; screw sill gate of 2 ft. thick x 2 ft. high. |
| 6 | Escape. | ..... | 17,500 | 5 spans of 40 ft. Counter-balanced Stoney gates. |
| 7 | Siphon. | Baum. | 700 | 1 span of 4 ft. |
| 7 | Siphon. | ..... | 1,044 | 1 span of 8 ft. |
| 8 | Foot bridge. | ..... | .... | |
| 8 | Siphon. | ..... | 14,020 | 7 barrels of 12 ft. |
| 9 | Road bridge. | ..... | .... | |
| 9 | Siphon. | ..... | 1,800 | |
| 9 | Foot bridge. | ..... | .... | |
| 10 | Foot bridge. | ..... | .... | |
| 10 | Siphon | ..... | 1,800 | |
| 10 | Foot bridge. | ..... | .... | |
| 11 | Siphon. | Gobinpur. | 17,000 | 12 barrels of 8 ft. |
| 12 | Foot bridge. | ..... | .... | |
| 13 | Foot bridge. | ..... | .... | |
| 13 | Culvert. | Sinnah. | 12,000 | 6 barrels. |
| 14 | Foot bridge. | ..... | .... | |
| 15 | Drainage inlet. | ..... | 760 | |
| 15 | Road bridge. | ..... | .... | |
| 16 | Level crossing. | Sukater, No 1. | 140,000 | Weir, 33 bays of 40 ft. |
| 17 | Drainage diversion. | Jabbi. | 8,000 | |
| 17 | Siphon. | Chinni. | 2,640 | 2 barrels. |
| 18 | Drainage inlet. | ..... | 175 | |
| 18 | Level crossing. | Sukater No. 2. | 60,000 | *Weir, 16 bays of 40 ft. |
| 20 | Culvert. | Gagora. | 2,100 | |
| 20 | Culvert. | Sadatpur. | 2,432 | 1 barrel. |
| 21 | Culvert. | Pashidpur. | 17,250 | 10 barrels. |
| 23 | Culvert. | Tora. | 1,400 | 1 barrel. |
| 24 | Level crossing. | Jaba. | 62,000 | |
| 26 | Culvert. | Kakrot. | 920 | 1 barrel. |
| 30 | Culvert. | Mehe. | 17,600 | 5 barrels. |
| 30 | Railway siphon. | ..... | 8,350 | |
| 29 | Culvert. | Aurangabad. | 13,277 | 5 barrels. |
| 30 | Culvert. | Kasba. | 10,404 | 3 barrels. |
| 32 | Culvert. | Khambi. | 1,241 | 1 barrel. |
| 33 | Culvert. | Simli. | 16,579 | 5 barrels. |
| 33 | Culvert. | Jalipers | 7,452 | 4 barrels. |
| 34 | Culvert. | Malo. | 1,955 | 1 barrel. |

*On each of the above weirs, 5 bays down stream are left 1 ft. low to keep regulator free from silt.

# Irrigation in the Land of the Five Waters, the Punjab, India,

By W. G. BLIGH,* M. Inst. C. E.

At the very root of the peninsula of Hindustan in its northwestern corner, five great tributary rivers debouch from the huge mountain barrier of the snow clad Himalayas, and pour their combined flood during the rains to an enormous extent into the Indus River, which mighty stream flows onward towards the Persian Gulf. The country enclosed between these five rivers is termed the "Punj Ab" or the "Five Waters," *punj* meaning five in the vernacular and *ab* water. The actual limits of the present province of that name extends considerably northward and southward of these boundaries, but its nucleus, the habitat of the Sikh race, is in the historic plain.

It was here that Alexander the Great's army overthrew that of Puru or Porus in 350 B. C., and here the first settlement of the Aryan invaders who imposed their languauge and religion on the greater part of the peninsula took place. Since those remote times the vicissitudes of the Punjab have been great and many. About the year 1000 A. D., together with the rest of India, this country was overwhelmed by the great Mohammedan invasion, which founded dynasties of Pathan, or Afghan, kings who ruled for centuries until another wave of conquest 500 years later, that of the sucessors of Genghis Khan, substituted the sway of the Mogul. This later invasion was contemporaneous with the conquests of Cortez and Pizarro in the New World. In more modern times the Punjab was conquered by the British forces but only after two sanguinary campaigns and six pitched battles. Thus we see that the "Land of the Five Waters" has a past teeming with romance and with deep historic interest.

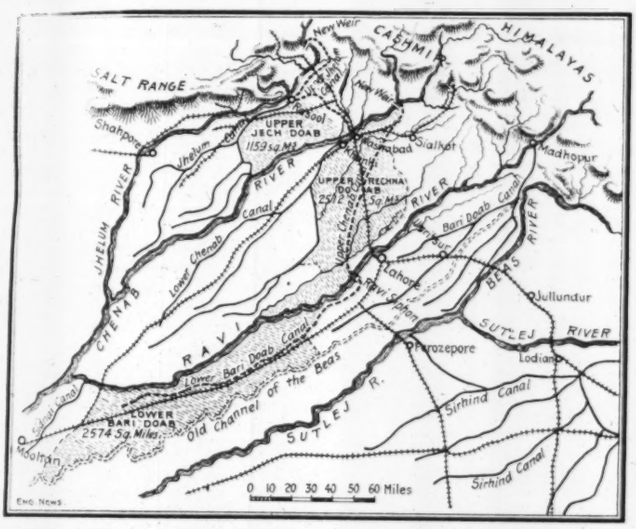


FIG. 1. MAP OF A PART OF THE PUNJAB, INDIA, SHOWING IRRIGATION CANAL SYSTEMS.

(Heavy lines indicate canals already built; dotted lines, canals in prospect. Hatched areas represent land to be put under irrigation by the new projects.)

The five tributary rivers mentioned are clearly shown in the accompanying map, and are the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej. The Jhelum is the Hydaspes of the ancients.

The land situated between two converging rivers is happily termed in the vernacular a "do-ab" or "two waters," in the same way as a delta represents the part enclosed by two diverging rivers. These doabs are designated by names formed by a fanciful combination of some of the consonants in those of the adjacent rivers. Thus the strip of land contained between the Jhelum and the Chenab rivers is termed the Jech Doab, in the same way that between the Ravi and the Chenab is termed the Rechna Doab, while the Beas-Ravi Doab is contracted into the Bari Doab. The Beas River, now united to the Sutlej in one stream, had in prehistoric times a separate channel right down to the Indus. The old course of the Beas is still traceable and its name is preserved by tradition, the tract between it and the Ravi being termed the Beas-Ravi Doab, not the Sutlej-Ravi Doab, to which it properly belongs.

The Punjab in ancient days, like many other countries, had originally a much larger population than at present; this must have been entirely due to the irrigation of the doabs, unless desiccation has set in, as these tracts at present, where not irrigated by the modern canals, are arid wastes incapable of supporting anything but camel thorn. Whenever water is available from wells or canals the population is dense. The great Sikh city of Umritsur has a population of half a million, and the upper part of the doabs where water is near the surface supports a thriving people which have outgrown the limited land available for their maintenance, consequently the construction of irrigation works to water the westerly arid tracts and bring them under cultivation is a matter of urgency.

The first canal system constructed in the Punjab was the Bari Doab, irrigating the upper doab of that name (see Fig. 1). It was commenced immediately after the annexation of the Province in 1848 with the special object of affording present employment and later land settlement to the disbanded "Khalsa" army. It was this beneficent measure, added to the firm and just government which so completely healed the wounds of this fierce strife, that the former enemies of the British "Raj" were its staunchest supporters in the time of dire stress and peril which came soon after when the whole Indian army of 200,000 men suddenly mutinied.

The next large work to be executed was the Sirhind Canal taking out south of the Sutlej, constructed in the decade 1875-1885. It was followed by the Sidnai Canal from the Ravi River near the city of Mooltan. This latter city has the unenviable reputation of being one of the hottest places on the globe, and it is an old saying that only a piece of brown paper intervenes between Mooltan and the nether regions.

The next work undertaken by the Government of India, now at last fully alive to the necessity of canal extension, was the Lower Chenab Canal. This is the largest canal in existence, if the Ibramiya Canal in Egypt is excluded. The full discharge is 10,800 sec.-ft., and it irrigates from 1½ to 2 million acres. It has 400 miles of canals and 12,000 distributaries. The lower Rechna Doab prior to the construction of this canal was an arid waste like parts of Arizona. The land was marked out in blocks of 1,100 ft. square, or about 27 acres, somewhat as is done in western America, and suitable immigrants were settled on the reclamation to the number of one million souls, and two million acres were thereby brought under cultivation. Financially its success was phenomenal, as the system returns a net profit of no less than 21%. This high return is due to the land having been originally State land of no commercial value, now rendered highly productive by irrigation.

The next large work taken in hand was the Jhelum Canal, the irrigation of which is not yet fully developed; this was constructed in the late nineties.

As will be seen from the accompanying map, the irrigation effected already by the Jhelum, Chenab and Bari Doab canals, large as it is, falls short of requirements. The upper Jech, the upper Rechna and the lower Bari Doabs still remain untouched. The reason for this is as follows: The upper Jech Doab cannot be reached from the present Jhelum Canal head at Rasool, the levels of the country not permitting it, so that a new canal taking out from a higher point on the upper Jhelum is a necessity.

For the irrigation of the upper Rechna Doab the same difficulty occurs with regard to levels, necessitating a new high level canal, in addition to which the Chenab River is incapable of supplying water in the cold season to a new canal, since when the river discharge is low, its whole available supply is required for the existing Lower Chenab Canal. The same hindrance occurs with reference to the Lower Bari Doab, the low discharge of the Ravi being already hypothecated for the Upper Bari Doab Canal, and for the Sidnai Canal. To obtain water from the Beas is impracticable.

These apparently insoluble difficulties have been overcome in the new Punjab Canal extension project which has received the sanction of the Secretary of State and is now under construction. The Jhelum River has fortunately a very large winter discharge. It runs through the Cashmere lakes for hundreds of miles and consequently its supply is more uniform throughout the year than that of the other four rivers, which partake more of the nature of mountain torrents. These latter bring down enormous volumes in the rainy season which can be utilized but very partially, whereas in the winter and spring months when water is in great demand for the valuable wheat irrigation and other crops the supply runs short. It is found by observations that the Jhelum River is capable of providing 10,000 sec.-ft. during this period in addition to fully meeting the wants of the existing Jhelum Canal, consequently it is from this river that most of the required supply can be obtained.

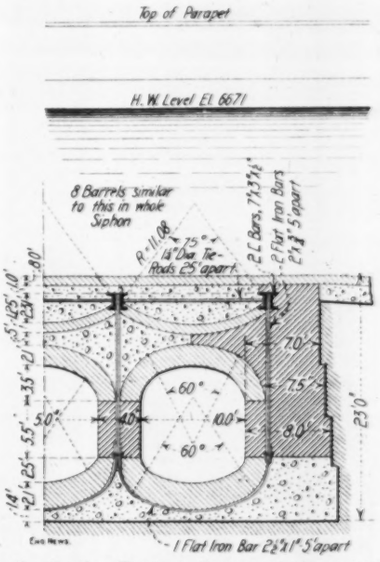


Fig. 2. Section Through Portion of the Originally Projected Ravi Siphon, Upper Chenab Canal.

The project consists, as is shown on the map, of a new canal intake on the Jhelum at a higher level than the existing one, the canal from which will not only irrigate the whole of the upper Jech Doab, but will tail into the Chenab River above the existing Khanki weir. This water from the Jhelum will be used for the supply to the Lower Chenab Canal. A weir is being built higher up the Chenab River, at Marala and from this new Upper Chenab Canal will take out; this will appropriate the former supply of the lower canal. It will pass through and irrigate the whole of the Upper Rechna Doab and after effecting this its surplus water, amounting in full supply to 6,500 sec.-ft., will be carried across the Ravi River

*44 Dupont St., Toronto, Ont.

by a level crossing debouching on to the Lower Bari Doab.

The new Upper Chenab Canal will have a full discharge of 11,700 sec.-ft., and the Upper Jhelum will not have much less.

Apart from the weirs and the heavy works necessary on these large canals in a broken mountainous country, the Ravi work will be a notable structure. It was originally intended to pass the canal across the Ravi through a siphon, a part section of which is given in Fig. 2. The design consists of eight barrels, 10 × 10 ft. in section. As the head of water acting on the roof is 27 ft., the arch of the barrel, unless made of very solid dimensions, which is impracticable, must be in tension, and is consequently tied round by steel bands to an upper inverted arch which will take the stress. The water in the siphon would have a velocity of 8 ft. per sec., and this would require a heading up of 4 ft. on the upstream side. Investigation has since proved that a level crossing would be a more economical construction and the siphon at this site has been abandoned in its favor.

The project will consist of 500 miles of canals and branches in addition to the Billoxi level crossing and 2,700 miles of distributaries and will irrigate 1,876,000 acres. Its cost is estimated at 32½ million dollars and the revenue 7½%. It will thus prove, in spite of its great expense, a profitable undertaking, but its value to the country cannot be estimated by mere revenue. It will cause the reclamation of vast areas from waste land to agriculture and further greatly enhance the value and productiveness of those portions which are already under cultivation.

The older canals in this part alone have the following discharges and acreage:

| | Discharge. | Acreage irrigated. |
|---|---|---|
| Upper Bari Doab | 6,500 sec. ft. | 900,000 |
| Sirhind | | |
| Sidnai | 2,400 " " | 195,000 |
| Lower Chenab | 10,800 " " | 1,600,000 |
| Lower Jhelum | 4,000 " " | 787,000 |

In addition are the inundation canals from the Indus, the Swat River and the Western Junna canals.

The next great work to be undertaken in this province will undoubtedly be a direct canal from the Indus involving a weir across that enormous river. This will irrigate the Sind Sagar, one of the most arid tracts in Asia. A great deal of irrigation is now effected from the Indus, but more in the adjoining Province of Sind, and entirely by inundation canals, the river itself not being bridled in any way.

All the old canals are river diversions, utilizing only the low discharge. For the further development of irrigation, large storage works in the hill country will have to be undertaken. There are few such works of any magnitude in India. A day will come, however, when this problem will have to be faced, as is already the case in the United States.

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FORESTRY OPERATIONS ON A LARGE SCALE have been conducted by the Pennsylvania R. R. for some years past, and recently the company has established two large tie and timber-treating plants. According to the 1910 report of the forester of the company, approximately 4,000,000 trees have been planted in the last nine years, opening with 13,610 in 1902 and increasing steadily to 801,625 in 1906; then dropping considerably, only to rise in 1909 to 1,054,010. In 1910 the number planted fell to 617,338. The forestry operations of the company cover tracts of land adjacent to its right-of-way on all points on the lines east of Pittsburg and Erie. A total of 32½ acres of land is devoted to nursery purposes at Morrisville, Pa. Here, ornamental plants as well as seedlings are grown for the use of the company. The two tie and timber-treating plants of the company, both for preserving timber by pressure treatment, are located at Mt. Union and Greenwich Point, Philadelphia, respectively, and have a combined annual capacity of 1,500,000 cross ties or their equivalent. Although the Greenwich Point plant was not put in service until July 1, 1910, yet during that year there were treated 671,369 ties, and 4,500,000 ft. of lumber and switch timber, besides considerable quantities of fence posts, cross arms, poles and 90,306 paving blocks. A total of 2,866,513 gals. of creosote oil, all imported from Europe, was used at the treating plants.

## The Pont Mirabeau Crossing of the Seine, Metropolitain Subway, Paris.

The most recently constructed section of the Metropolitain subway in Paris, France, that which extends from Auteuil to the Opera, by way of Grenelle, makes two crossings under the Seine, one just below the Pont Mirabeau and one near the Pont de la Concorde. The latter is a tunnel driven by the well-known shield method and has no points of extraordinary interest, but the former was built by the more exceptional method of sinking in place a succession of independent caissons and joining them together in the bottom of the river to form the tunnel section. In one other Seine crossing of the Metropolitain, the Chatelet-Place St. Michel* section, this same general system of construction was used, but in the Pont Mirabeau crossing an entirely different method of connecting the caissons was devised. A description of this method, taken from the issue of "Le Genie Civil," March 11, 1911, is given below:

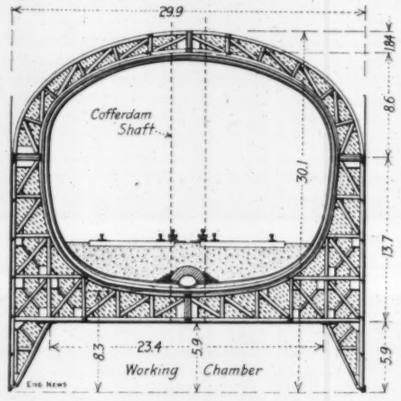


Fig. 1. Section Through Caisson Forming Tunnel of Paris Metropolitain Subway, Near Pont Mirabeau, River Seine.

The river proper section of the crossing is 644 ft. long and is made up of five separate lengths of caisson, varying from 116.8 ft. to 144.4 ft. in length and all of the general design shown in the section in Fig. 1. This is typical of this system of construction, a framework of steel angles and channels covered on both inner and outer faces and at both ends with steel plates, so as to form an inner opening, which can be lined to the shape of the desired tunnel section, surrounded by a braced annular portion, into which concrete can be placed. The end plates cover the whole section, so that, by the aid of the central shafts shown, the bottom can be used as a compressed air working chamber and the whole box or caisson sunk to any required depth. The caissons are built up on shore, floated to their proper location and then sunk by filling the cellular space with concrete, excavating and removing the earth under compressed air through the working chamber.

In the previous use of this type of construction on the Seine, the adjoining caissons were sunk 4.92 ft. from each other, in proper line and on proper grade. This 4.92-ft. space was then flanked on each side by sinking, under air, a wall of concrete extending from the river bottom to the top of the caisson, making with the ei wall of the caisson, a complete enclosure of th ter- vening earth. On top of these four wall cere was then sunk a cofferdam roofed to keep the river with open shaft extending up into air In these cofferdams workmen, under free ex- cavated the earth in the inter-caisson spac cut the plate end diaphragms of each caisson and extended the plates and lining of the nnel across the opening.

At the Pont Mirabeau crossing a differen eth- od, illustrated in Fig. 2, was used. Fi the caissons were provided with square-toppe nds, with their upper planes level with the hest outside elevation of the crown of the tunn ais- son arch. The caissons were sunk to th re- quired line and grade, with an interveni lon- gitudinal space of 15¾ ins. between each ad- joining caissons. There was thus left betwe each two caissons a space 15¾ ins. wide, 30 deep and 30 ft. long, filled with the water-bear clay and marl common to this portion of th Seine bottom, and with its top at or about th bot- tom of the river. At each end of this spa here was then sunk, snug against the edges the caisson, a hollow iron cylinder, 20 ins. outside and 15¾ ins. inside diameter, to the depth of the working level in the caisson. The interiors of the cylinders were then excavated and filled with concrete, thus completely shutting off the inter- vening space from the sideways access of water.

The earth from the enclosed space was then excavated to an elevation about 5 ft. above the working level in the chamber and the space filled, by bottom opening tremies with concrete up to the level of the top of the caisson. This concrete was laid as a continuous operation, extending over 48 hours. After the wall of concrete had been in about one month the working chambers of the caissons were filled with concrete. The tunnel sections were then entered from the shafts and an opening the shape and size of the tunnel section cut through the diaphragms and the 15¾-in. concrete wall and the concrete tunnel lining made continuous between the two sections.

The tunnel is on a grade from either bank to the middle, which accounts for the difference in elevation in the caisson bottoms shown in Fig. 2.

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A BOREHOLE 7,347 FT. DEEP was put down at Czuchow in Silesia recently, according to foreign journals. Temperature measurements at different depths showed an average temperature gradient of about 55 ft. per degree F., but near the middle this increased to 31 ft. per degree, while in the lower third the gradient was only 91 ft. per degree. The temperature near the bottom was 182° F.

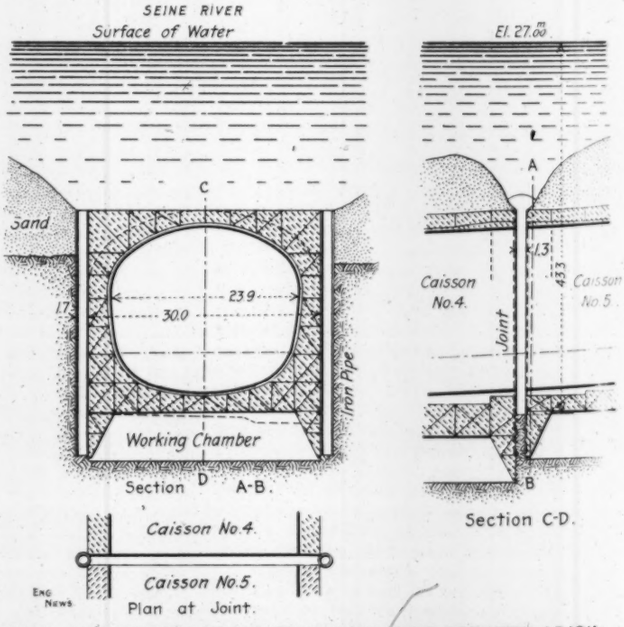



FIG. 2. DETAILS OF METHOD OF MAKING JOINT BETWEEN ADJOINING CAISSONS, PONT MIRABEAU CROSSING, METROPOLITAIN SUBWAY, PARIS.

*This crossing was described in Engineering News, Feb. 15, 1906, p. 177, and April 11, 1907, p. 400.

## A 1,000-HP., Oil-Fuel Producer-Gas Power Plant.*

1,000-HP. gas-electric power station is being built by the Holton Power Co. at El Centro, Cal., which is a feature of great novelty, three 400-HP. oil-fuel gas producers. This is especially interesting as the oil has an asphalt base, and while it has been generally believed that the only satisfactory method of using such oil as fuel has been by burning it under steam boilers, the designers of this particular producer have favored to secure a permanent gas producer design at a temperature which would vaporize the asphalt bases into a vapor that

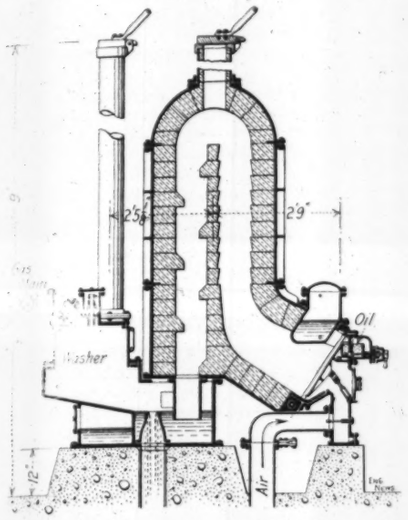



Fig. 1. Sectional Elevation of a 400-HP. Gas Producer Using Fuel Oil with Asphaltum Base.
(International-Amet Gas Power Co., Los Angeles, Cal.)

would be carried to the engine cylinder, there to come down as solid carbon to score the walls.

The system to be used, the so-called Amet-Ensign, generates a gas which is claimed to hold about 70% of its heat in fixed hydro-carbon compounds, the rest being in carbon monoxide and free hydrogen, 12%, by volume, being the largest quantity of hydrogen shown. It is stated that the most advantageous thermal value of this gas lies between 200 and 250 B. T. U. per cu. ft., though gas may be produced having a value from 170 to 270 B. T. U. The following characteristic analysis has been given by the company:

| | 267 B. T. U. | 225 B. T. U. | 210 B. T. U. |
|---|---|---|---|
| $CO_2$ | 4.2 | 5.4 | 6.5 |
| O | 0.2 | .3 | .4 |
| CO | 8. | 8.6 | 7.8 |
| $C_n H_{2n}$ | 2. | 4.2 | 4. |
| $C H_4$ | 16.2 | 7. | 6.0 |
| H | 12. | 10. | 9.8 |
| N | 57.4 | 64.5 | 65.5 |

Difficulty in the control of the thermal value of the gas under different conditions of load has been overcome by automatically keeping the oil at a fixed temperature to maintain constant viscosity and for regulating the quantity of oil in its proper relation with the quantity of air being forced into the producer. The proportions of oil and air are adjustable and under control of the operator, but after a particular adjustment has been made the load can be varied over a wide range with practically constant thermal value of the gas.

The oil fuel is fed in from a weir-box, (Fig. 1), which has an adjustable needle valve. The oil runs down the adjacent inclined plate, and air comes up a pipe from below to pass around the lower edge of the oil plate. In actual operation, only the thicker asphalt compounds even reach the lower edge there to burn and to maintain the heat necessary for the gasification of the lighter constituents of the oil. The products of combustion and distillation pass up through the bricklined combining tube and down again to the first water seal. The relative amounts of oil and air fed in are kept constant with varying load (varying amounts of gas made) by utilizing the difference of pressure on two sides of an orifice through which the air passes and by applying this difference to the oil and the weir-box, to change the flow correspondingly. The designers claim this automatic control of the relative proportion of oil and air to be one of the vital features of the system, lack of which may account for the failures of others to build a satisfactory producer. After passing through the first seal, the gas goes through a rotary washer of special design, details of which are not shown in Fig. 1.

Burn-out valves are placed at the top of the producer proper and on a stand-pipe connected to the gas main beyond the washer. These valves are used mostly in starting up; with the smaller sizes of producers it is occasionally necessary to open the burn-out valves at intervals to clear the combining tube of a soft deposit of carbon. This is a momentary operation, during which the oil is shut off. After a producer has become thoroughly heated and is running regularly, this burning out need be done only at intervals of several hours.

Since the flow of oil through the needle orifices and over the weir is dependent on viscosity as well as pressure, it is necessary to maintain the incoming oil at a fairly constant temperature. In this system it is effected by passing the oil supply through a water-jacketed compartment, the circulation of water being controlled by a thermostat in the oil. A rated horse-power of these producers is understood to mean a capacity to make gas having a total heat value of 10,000 B. T. U. per hour, as shown by chemical analysis and calorimeter measurements.

One of the first units put into commercial operation was built for the U. S. Reclamation Service at Yuma, Ariz., supplying gas for two 50-HP. engines to operate a scoop-wheel for raising water from the Colorado River. While this producer was imperfect, compared with the present ones, it is reported to have given good satisfaction in both economy and reliability. The guarantee for the Yuma plant was 6.5 B. HP. per gal. of oil, but this has been considerably exceeded. No interruption of service, through fault of the producers, has been reported, and the engine cylinders are still in good running condition. A 200-HP. plant, which has been running at Avondale, Ariz., for several months, has been shown by test to develop 10 B. HP. per gal. of oil at three-quarter load.

One great advantage claimed for this system is the possibility of instantaneous operation from the cold plant. Gas is generated at the instant the fire is lighted, making it possible to operate the producer in large installations at maximum economy by cutting out or putting on units with load changes. The efficiency of gas generation is lowered for only about 15 minutes after starting, it is claimed, and then by only a small fraction of the maximum figure. In warm weather, or by artificially heating the fuel oil in cold weather to 100° F., a producer can be put into full operation under full load in from 1.5 to 2 minutes—the time necessary to start auxiliary apparatus, like the washer. It is claimed that one man may operate a plant up to 300-HP. capacity, and with special care in laying out the machinery one man may operate up to 500-HP. capacity. The actual attention required is regular and about that which should be given to a similar capacity of oil-fired boilers. That is, each single producer needs attention for about three minutes out of each half hour.

El Centro, where the 1,000-HP. plant is being built, is in the heart of the Imperial Valley of California and is about 50 ft. below sea level. With the completion of the irrigation projects of this section, numerous small towns have sprung up, and to supply these several places with electricity the Holton Power Co. has built a hydro-electric plant at Holtville with a steam auxiliary at El Centro. This gas-engine plant is an addition to the latter to provide for the rapidly growing load. The new plant will be housed in an addition to the present buildings. The three 400-HP. Amet-Ensign producers will supply one 1,000-HP., twin, tandem, gas engine direct-connected to a three-phase, 60-cycle, 2,400-volt, 150-r. p. m., alternator. For voltage regulation, a 15-ft., 40,000-lb. flywheel will be provided, and it is expected to operate the gas-engine unit in parallel with the water and steam-driven units. It is proposed to store the main oil supply in a concrete tank, from which it will be piped to an auxiliary tank and be pumped to the producers.

The only water-supply for this installation will be for the gas washer, for the oil-chamber water jacket and for the engine jackets. The amount used for engine cooling will be comparatively large, but it is proposed to use the supply continuously, the only loss being by evaporation from the cooling tower. The general layout of the producer house is shown in Fig. 2.

The designers are already figuring on a duplication of the plant now under way, and it is expected that a single producer of 2,000-HP. will be built instead of three more 400-HP. units. One such producer of 2,000-HP. has already been built and tested. It is reported to be built on slightly different lines and is claimed to show advantage over the rectangular type, both in capacity per unit of size and in efficiency.

As the El Centro works, to which this gas-producer installation is being added, comprises an illuminating-gas plant, making lamp-black as a by product, the lamp-black made by these producers and recovered in the washer will be delivered to the settling tanks of the other gas plant. Lamp-black has been burned under a boiler in connection with the illuminating gas processes, but not quite enough has been available heretofore to furnish the total amount of steam required.

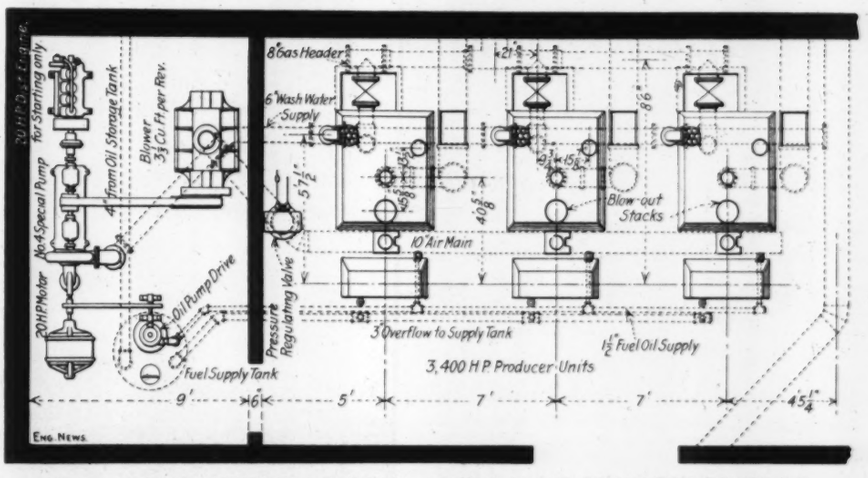



FIG. 2. PLAN OF PRODUCER ROOM, EL CENTRO PLANT OF HOLTON POWER CO.

*From information supplied by the International-Amet Gas Power Co., 609 Central Bldg., Los Angeles, Cal., and the Allis-Chalmers Co., Milwaukee, Wis.

# Steel and Concrete Dock Wall; Renewal of South End of Dock No. 10 in Ashtabula Harbor, O.

By CHARLES BENHAM, JR.*

The Pennsylvania Company recently completed the renewal of 585 ft. of dock on the Ashtabula River, Ashtabula Harbor, O. The old dock was of wooden crib construction; it had reached the limit of its service, and was starting to cave in. The dock is situated along the west side of the river, and supports the four-track hump supplying coal to the car dumper operated by the M. A. Hanna Co.

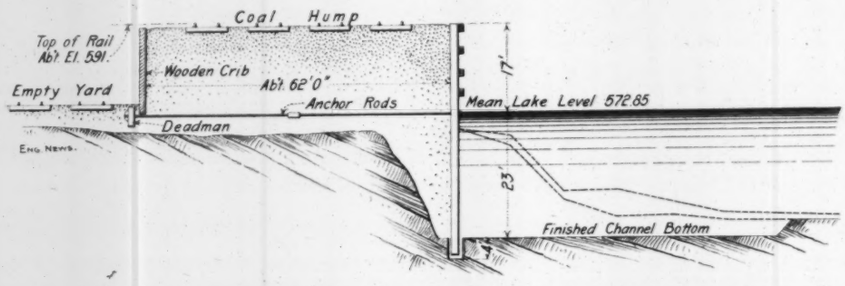



FIG. 1. CROSS-SECTION SKETCH, NEW DOCK NO. 10 OF PENNSYLVANIA COMPANY ON ASHTABULA RIVER, AT ASHTABULA, O.

The construction requires to be strong, because the traffic is heavy and frequent. Most of the other docks in the harbor are of timber construction, and they naturally have rotted at the water-line in course of time. About four years ago a dock wall consisting of steel posts, each made of two 10-in. channels, and timber wales holding vertical timber sheeting was built just south of Dock No. 10; there are no tracks near the face of this dock, however.

Three schemes were proposed for the new construction of Dock No. 10: (1) a structure entirely of reinforced concrete; (2) one similar to the dock south of No. 10 and (3) the adopted plan, in which the sheeting is horizontal. The adopted method avoids the use of 12 × 12-in. supporting timbers below the water-line, and facilitates placing the sheeting.

The contract was let to the Great Lakes Dredge & Dock Co., of Cleveland, O. Removal of the old dock was covered by a lump sum, the dredging by a cubic-yard price, and the dock construction by a lineal-foot price. All extra work was covered by a force-account clause in the contract.

The dock (Figs. 1 and 5) consists of posts built up of two 18-in. 55-lb. I-beams, of length up to 44 ft. These extend 27 ft. below mean lake level and are set 4 ft. in the solid bedrock of the river and concreted in with a 1:4 cement-sand mixture. The posts are spaced 7½ ft. c. to c. and are anchored by a 2¼-in. round iron rod to a reinforced-concrete "deadman," 65 ft. back of the face of the dock, just west of the crib supporting the west side of the coal hump.

Above the rock surface the dock face is made by 6 × 12-in. timber sheeting to within 18 ins. of mean lake level. The sheeting is sealed at the bottom by a toe of bags containing 1:4 cement mortar. Above the sheeting the face consists of 6-in. reinforced-concrete slabs.

*New Castle, Pa., Assistant on Engineer Corps, Pennsylvania Company; Engineer-in-Charge of Renewal of Dock No. 10.

The deadman or anchor wall is a 14-in. reinforced-concrete wall, 4 ft. high, made of 1:2:4 mixture. Fig. 5 shows the arrangement of the reinforcing steel.

It was specified in the contract that the contractors were to maintain the two west tracks during construction. In order to properly provide for this the third track was torn up and four-pile bents were driven 10 ft. apart. The piles of these bents were driven to rock; they averaged 18 ft. long. They were first-class white oak, 14 ins. at the butt. The piles were capped with a 12 × 12-in. oak timber, on which rested two 10 × 18-in. stringers under each rail. This arrangement formed a standard trestle under the entire length of the third track. It proved to be the life of the job, for although the hump was dredged away back to the piles and the track was used constantly the greatest settlement in any place was less than 2 ins.

The pile-driving was hard, for the hump was a fill of granulated slag that had become cemented.

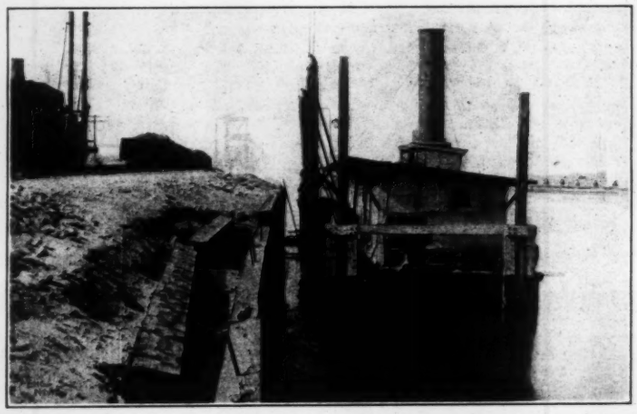


Fig. 2. Old Timber Dock.

The old dock was easily torn apart with a derrick scow, dynamite being used to loosen the timbers and cemented slag. Previous to tearing out the old dock the river was dredged to a depth of 23 ft., the rock being drilled and blasted. After removal of the material behind the dock [illegible] was core-drilled 4 ft. back of the dock [illegible] for the whole length of the dock. This was [illegible] to prevent the loosening of the strata of rock [illegible] the dock line, which would bring too [illegible] at a pressure against the dock.

The posts were set in 24-in. holes drilled into the rock to a depth of 4 ft. Three Ingersoll-Rand drills that had been used in drilling 2-in. holes for blasting the river bed were rigged up to drill the 24-in. holes. Two types of bit were used, one forged solid with the shaft, and the other with a cutting-head forged separate and bolted to the shaft. The former proved more efficient; it is shown by Fig. 4. A small jet-pipe leading into the hole kept the hole clear of debris. A churn drill was used on the first hole, because of the cramped location, but it was much slower than the steam drills.

Considerable trouble was experienced in drilling on account of lumps of slag and salamander falling into the holes and battering the teeth of the bit. On the last hole it was necessary to place an iron cylinder around the drill and pack it around the outside with bags of sand to keep out foreign material.

The posts were painted and loaded on a large derrick scow. They were lowered into the holes by means of the derrick, the holes having been washed out by a diver with a hose connected to a pump on the scow. After the post was in position and braced from the shore and adjacent posts, concrete in sacks was lowered to the diver at the base of the post, who cut the bags and placed the concrete in the holes. When the hole was filled, one or two empty sacks were placed on top of the concrete and weighted down with stones to keep the cement from washing out.

The anchor rods were driven from the river side (Fig 7). These rods did not come out at their exact proper location on the deadman side, the greatest difference being 2 ft. When forms were placed for the deadman, the reinforcement was placed symmetrically with respect to the anchor rods, and additional width given to the deadman and additional reinforcement, where necessary, to give each anchor rod its proper amount of wall area for uniform pressure.

The concrete for the anchor wall was mixed on a flat car on the empty yard track next the crib and deposited directly into the forms.

The concrete for the slabs was mixed on a derrick scow in front of the dock. The lower sections were placed by hand. The upper sections were placed by means of a bucket opening on one side and handled by the derrick. The forms for the slab at and below the water-line were made of matched lumber.

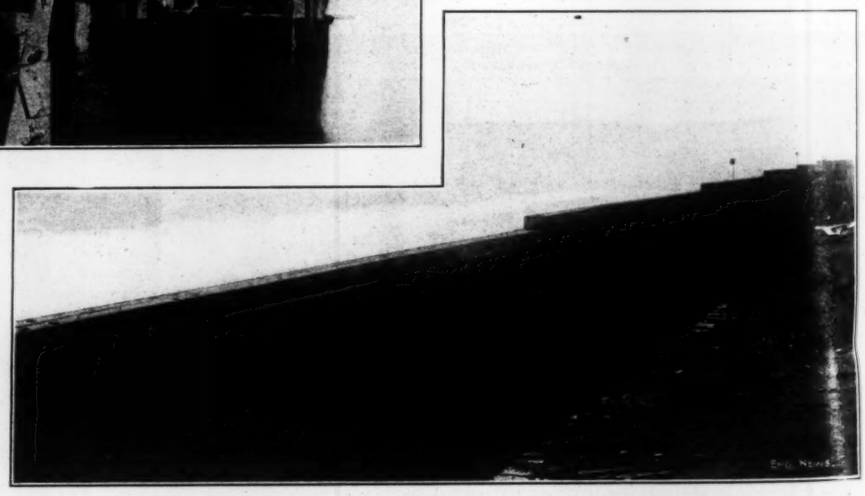


Fig. 3. Inside of New Steel and Concrete Dock Wall, Before Filling.

FIGS. 2 AND 3. OLD AND NEW CONSTRUCTION, DOCK 10, PENNSYLVANIA CO., ASHTABULA, O.

# A Test for Galvanized Iron to Replace the Copper-Sulphate Method.*

By W. A. PATRICK and W. H. WALKER.†

RESULTS OF THE PREECE TEST.—It has been shown that the so-called Preece test for galvanized and other coated iron is unsatisfactory from many points of view, although no alternative method has been equally available. It is now believed that a satisfactory substitute can be given and the proposed method is outlined herein.

The Preece test consists in placing the piece of galvanized iron to be tested in a solution of copper sulphate under standard conditions, and observing the number of one-minute immersions which can be made before a bright adherent film of copper will plate out on the piece.

The accuracy of this test depends upon the assumptions that the zinc will pass into solution and be replaced by copper at a definite rate and that the time

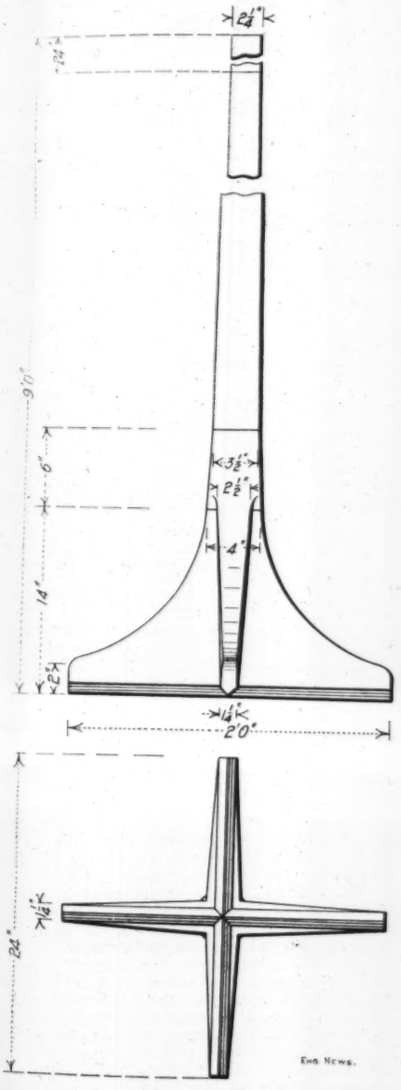



Fig. 4. Drill-bit for 24-in. Holes, Ingersoll-Sergeant Drill.

taken to dissolve a galvanized coating will measure its thickness; (2) that the galvanized coating is homogeneous and that the speed of reaction between the coating and copper sulphate is constant, and (3) that only when the iron base is reached will bright copper plate out on it in distinction to the black spongy form appearing on the zinc.

The structure of galvanized articles is such as would preclude the possibility of the Preece test being a valid one. The coating of an ordinary hot-dipped sheet or wire is made up of three well defined parts (1) the iron base, (2) a layer of iron-zinc alloy, and (3) a layer of zinc. The alloy is much less electro-positive to iron than zinc, but it is not electro-negative. Since the rapidity with which the zinc or zinc alloy will pass into solution and an equivalent of copper will be precipitated is a function of the difference of electric potential between the two metals, then the rate of solution must change in passing from zinc to zinc-iron alloy. The so-called "sherardized" and some electro-galvanized iron coatings consist largely of an alloy so that any test based on an assumed uniform rate of solution is liable to grave error.

For the first few seconds after a piece of clean zinc is placed in a concentrated solution of copper sulphate, the reaction is rapid but, as the spongy copper forms, the reaction speed decreases. At the end of a minute, the reaction has practically ceased. When the sponge of precipitated copper is removed and the test piece is replaced, the reaction repeats as above. The iron base may be practically exposed at the end of the second minute, and yet no bright copper may be seen until the sponge is removed at the end of the third minute. Such a test piece would be classed as a "three-dip coating," while in reality it is but a trifle over "two-dip," and an error of 33% is introduced. Galvanized iron which has areas of no coating whatever would be classed as "one-dip," when in reality it was "zero-dip."

It has been proposed to remove this difficulty by using a greater number of ten-second immersions in place of one-minute immersions, but a new difficulty arises. When a piece of iron is placed in a neutral copper sulphate solution, copper plates out in a bright adherent film and appearance of this copper is taken in the Preece test as proof that the zinc has already been dissolved and the iron base exposed. Now, if a piece of smooth speiter or sheet zinc is given a number of ten-second immersions in a copper-sulphate solution, a point of bright copper will appear which will spread over the entire surface as the test proceeds, and were the specimen a galvanized article instead of pure zinc the erroneous conclusion would be reached that the iron base had been uncovered. This layer of bright copper is formed more easily on the zinc-iron alloy than upon pure zinc.

THE PROPOSED BASIC LEAD-ACETATE METHOD.—When a zinc-coated iron article, free from the products of corrosion, is placed in a basic lead-acetate solution, at ordinary temperatures, the coating passes into solution and an equivalent amount of metallic lead is precipitated in a loosely adherent form upon the specimen. This lead is easily removed and the coating determined by measuring either the loss in weight of the test specimen or the lead precipitated.

When employed in the same way as the Preece test, the lead-acetate method has important advantages. A bright copper surface on the zinc cannot be distinguished from the bright copper on the iron base while, in the lead-acetate test, bright adherent lead may be precipitated, but cannot be mistaken for the bright iron disclosed. Thus, if it is desired to make a rough test for uniformity of coating on a wire, one-minute dips may be employed and the uniformity with which the bright iron appears indicates the evenness of the coating.

The reaction between the zinc coating and the lead acetate is retarded by the precipitation of the lead, and therefore when a heavily galvanized piece is being tested the lead must be periodically removed.

The size of sample must depend on the material under investigation. In the case of sheets or plates a piece 2 × 2 ins. is desirable, and for wire a piece 3 to 6 ins. long, according to the gage. The longer the test piece the smaller is the percentage error of measuring. The size of the wire and sheet should not vary more than 1/64-in. from standard gage. The specimen should be weighed to three decimal places if possible when gravimetric determinations of loss of coating are made.

The solution should be made up as follows: 400 grams of crystallized lead acetate are dissolved in one liter of water and four grams of finely powdered litharge is added. The mixture is shaken until most of the litharge is dissolved. Any insoluble residue may be allowed to settle to the bottom and the clear solution later decanted and diluted to a specific gravity of 1.275 at 15.5° C. This produces a solution of basic lead acetate which dissolves zinc and zinc-iron alloy but does not attack the iron base.

Enough of the solution should be used to completely cover the specimen. The specimen should be so placed in the container that the zinc surface is completely exposed to the solution.

Test specimens should be allowed to remain in contact with the solution for three minutes. The adherent lead is then removed, but a burnishing action must be avoided, as under some circumstances closely adherent lead may be plated out on the zinc. The specimen is then replaced in the solution and after another three-minute immersion the lead is removed as before. This is repeated until the bright surface of iron is exposed. Four three-minute immersions are usually sufficient. The bright iron base differs so radically in appearance from both the spongy lead or even lead in the form of a bright adherent film that a lack of uniformity in the thickness of coating is readily detected. This is an important point in testing wire. A thin place on the wire may frequently show the bright iron surface after the first immersion, and some specimens have been found which carried no coating at all over considerable areas.

Either a volumetric or gravimetric method for determining the thickness of coating may be employed. If the volumetric method is used, the adherent lead must be preserved, while, if the specimen be weighed, the lead may be discarded. However, on account of the size of some specimens, it is often found desirable to collect and weigh the lead.

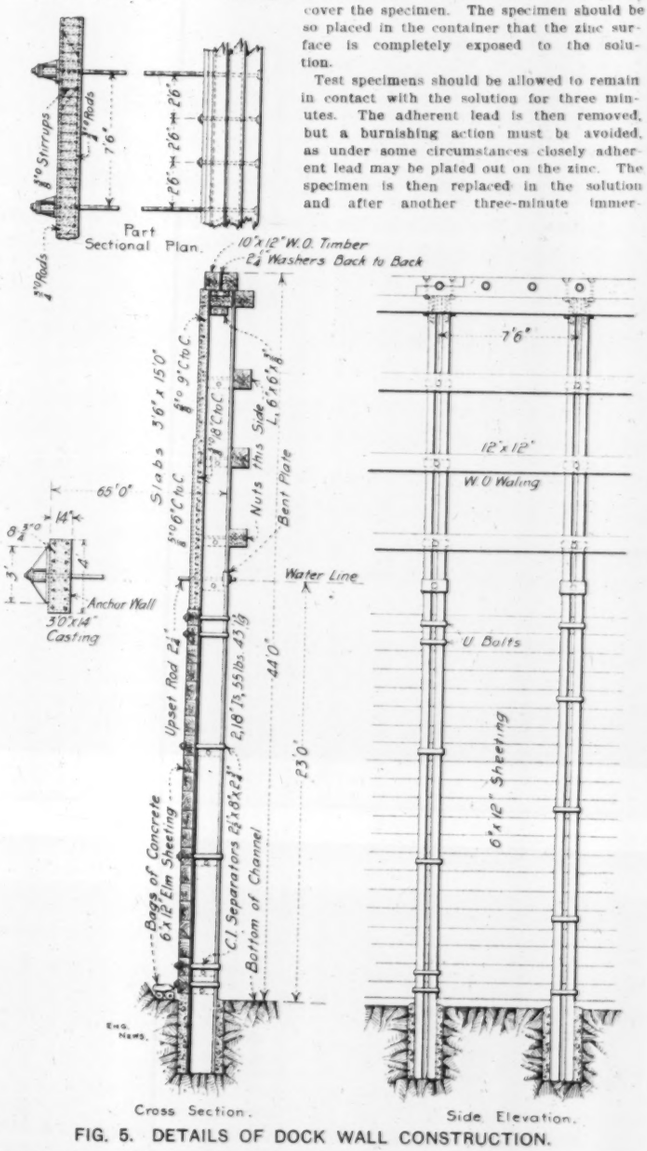



FIG. 5. DETAILS OF DOCK WALL CONSTRUCTION.

*A contribution from the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, briefly abstracted from the Journal of Industrial and Engineering Chemistry published by the American Chemical Society, April issue.

†Research Laboratory, Massachusetts Institute of Technology, Boston, Mass.

When the coating has all been removed and bright iron only is visible, the lead is quantitatively determined or the iron base is dried and re-weighed. For a gravimetric determination, the bright iron piece is thoroughly washed with water, rinsed in alcohol, dried and weighed. The difference between the original (before test) and second weighings gives the weight of coating on the specimen. Suitable factors and formulas for converting this into weight per unit area are given below. If the weight of the test specimen be very large compared to the weight of the coating, small errors in weighing invalidate the accuracy of the test. In this case it is better to collect the lead, wash with boiled water and weigh.[1]

The weight of zinc coating per mile or per unit area can be determined volumetrically as follows: The accumulated lead is washed by decantation several times with hot water previously boiled until free from lead acetate. The metallic lead is dissolved in a small quantity of concentrated nitrate acid; for instance, 2 cu. cm. This solution is then neutralized with a slight excess of ammonia and without filtration is redissolved in acetic acid. A standard solution of potassium chromate ($K_2CrO_4$) is prepared containing exactly 12.624 g liter. Potassium chromate reacts with lead acet ing a yellow lead chromate. On the other han chromate is deep red, so that if a little of the s lead-acetate solution is placed on a paper co silver nitrate no reaction will be observed so there is any lead acetate in the solution, but the n enough potassium chromate is added to entirely p tate the lead the first drop of excess potassium chr will color silver-nitrate paper red and thus det the end point of the reaction. By measuring from rette the exact number of cubic centimeters nece give the first indication of red with silver nitrat the weight of zinc per unit area can be directly co from the following factors:

[1]Note.—In the reaction, $Pb\ (C_2H_3O_2)_2 + Zn = Zn\ (C_2H_3O_2)_2 + Pb$; one molecule of lead replaces one of zinc. The atomic weights of lead and zinc are respectively 206.9 and 65.4 so that one gram of lead precipitate, obtained as above, indicates the solution of 0.3155 gram of zinc.—Ed.]

Fig. 6. Steel Posts in New Dock Wall in Position.

Fig. 7. Driving Anchor Rods.

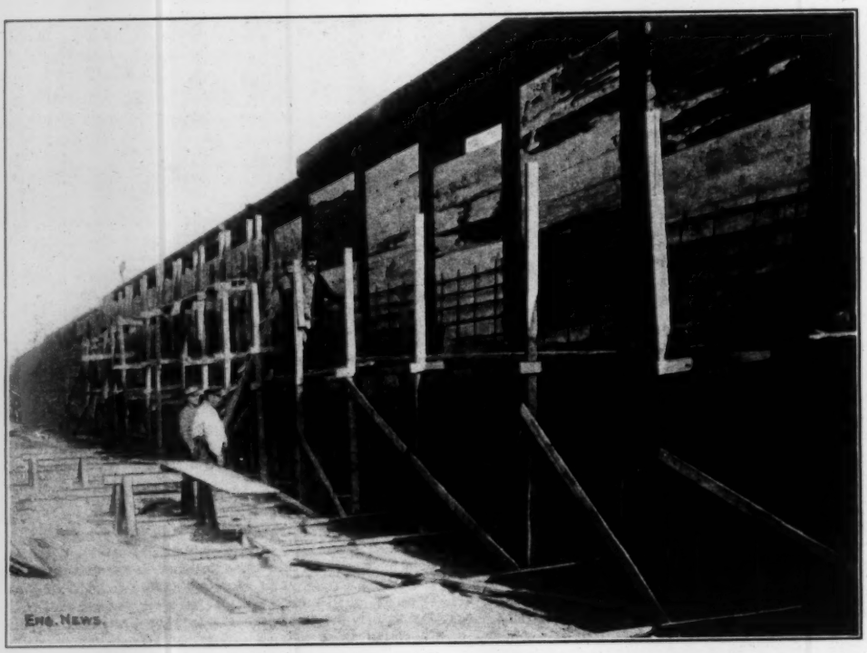



Fig. 8. Forms and Reinforcing for Concrete Face Slab.

FIGS. 6, 7 AND 8. VIEWS DURING CONSTRUCTION OF NEW DOCK 10 OF PENNSYLVANIA CO., AT ASHTABULA, O.

FOR WIRE.

| Length of test piece taken in ins. | Factor for conv cubic centi ters (std. sol. chr into lbs. coating |
|---|---|
| 1 | 0.60 |
| 2 | 0.30 |
| 3 | 0.20 |
| 4 | 0.15 |

FOR SHEETS.

| Size of test specimen. | Factor for conv cubic centim (std. sol. chromat ounces coating |
|---|---|
| 1 sq. in | 0.0213 |
| 4 sq. ins | 0.0053 |

Working charts may easily be prepared from w the desired data can be read off directly on know the results of the determinations. The following fo express the relationships most frequently used for gravimetric and volumetric determinations:

Let $X$ = pounds coating per mile of wire.
Let $Y$ = ounces coating per sq. ft. of sheet.
Let $N$ = cubic centimeters potassium chromat solution used.
Let $L$ = length of test piece in ins.
Let $S$ = area of test piece in sq. ins.
Let $G$ = loss in weight in grams.

$$X = \frac{139.86 \times G}{L} = \frac{0.60 \times N}{L}$$

$$Y = \frac{5.090 \times G}{S} = \frac{0.0213 \times N}{S}$$

Manufacturers of sheet and wire publish small handbooks giving the gage, relation of weight to area and length, etc., useful for further calculation.

The iron which is in combination with z alloy will pass into solution during this proce as iron acetate, and can be determined as follow The lead acetate solution of the test, together with the wash waters from the metallic lead, is heated to boiling and the lead precipitated with a slight excess of sulphuric acid. The iron is oxidized with nitrate acid, precipitated with ammonia and washed and weighed as iron oxide. If no balance be available, it may be washed, re-dissolved in sulphuric acid, reduced with zinc and titrated with standard potassium permanganate solution.[2] An idea of the amount of iron and the different kinds of zinc-coated iron may be obtained by the following results from tests of products found in the open market:

| Kind of material. | Iron in coating, per cent. |
|---|---|
| Ordinary hot dipped sheet | 2.20 |
| Sherardized plate | 11.50 |
| Wet galvanized (electro deposited) sheet | trace |
| Wet galvanized (electro deposited) sheet | 7.46 |

NOTES ON THE LEAD-ACETATE TEST.—To insure the absence of free acetic acid, and to eliminate danger of attacking the iron base, the test solution must be made slightly basic by the addition of litharge as shown.

It is important to immerse the specimen for periods not shorter than three minutes to prevent a coherent deposit of lead. In the case of weathered articles, it is necessary to remove the layer of zinc salts from the surface by immersion in dilute hydrochloric acid.

In washing the deposited metallic lead free from lead acetate for very accurate work, it is necessary to use water previously boiled to free it from oxygen and carbon dioxide ($CO_2$).

To obtain exact lengths of wire, it is well to cut the specimen longer than desired and file to exact measurement.

If the iron in the alloy layer is determined by titration with potassium permanganate, it is necessary first to remove it from the acetic acid as with acetic acid present the titration is not accurate.

The size of the specimen which can be used with the volumetric method is limited by the amount of potassium chromate solution required for reacting with the precipitated lead. Three inches of wire is all that is necessary, except that greater accuracy in measuring is obtained with a longer piece.

[2]Note.—Standard potassium permanganate solution for metallic iron carries 2.822 grams of permanganate per liter and 1 cu. cm. is equivalent to 0.005 gram of metallic iron. All such solutions need to be carefully standardized in the laboratory to check or correct such equivalent values.—Ed.]

# Mine-Survey Notes.*

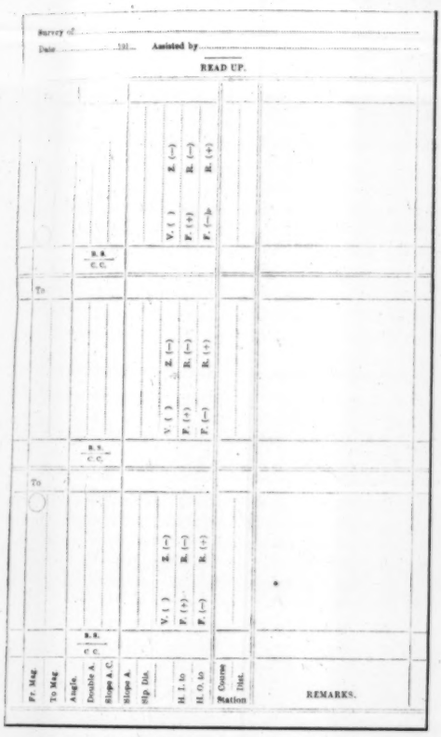
GEORGE W. RITER, M. Am. Inst. M. E.†

...stinguished engineer, the active head of a large ... company, has said that surveying attains the ... of a profession only in the hands of a few men—... who know how to keep notes that will be ...d by even a novice without further word of ...on.

... mine-records, survey notes are perhaps the ...portant. The maps made from them serve as ...ng-guide, and as framework for other data; ... from any cause, access to underground work- ...t off, the surveyor's record often becomes ...

...om does a surveyor have a chance to check ...nd surveys by making a closure, that he is ... to rely on the precision of each step of his ... the accuracy of the final result. When data ... recorded on the spot, the notes, even in the ... second parties, become evidence of the care ... ision with which the surveying was done. It ... a great deal to be able to pick up the work of ...rmer surveyor where it was left off, and to be able to carry it forward without retracing from the beginning.

The purpose of this paper is to describe the survey-note system of a mine now under my direction, in which




Form 1.—Blank for Actual Field Notes.

underground surveys had to be relied upon entirely for the proper division of rich ore-bodies between neighbors, thereby placing a premium on accurate surveying and permanent records.

In survey-work, it soon turns out that paper is the least item of expense, and that little is gained by trying to economize note-book space. For many purposes it is best to record notes on cards or loose-leaves, which may be left in the office at the end of the day's work and need not be carried into the mine again, there to become smeared with grime and grease. With the loose-leaf or card system, all notes relating to the same locality may be filed or bound together, and additional loose-leaves, containing diagrams or office-calculations, may be inserted opposite the original note pages. If for any purpose a bound book is to be preferred, the books can be so put together that pages containing diagrams, etc., may be interpolated wherever desired and securely fastened. In any event, it is well to keep the field-notes and calculations in such a way as to show which were made in the field and which in the office.

Nothing is more annoying than to discover, while working up notes in the office after the field-work is done, that some important reading has not been recorded and that a special trip to the workings is necessary to get the missing data. In the surveys herein referred to, it was decided to provide blank notes, ruled and printed specially for the work. Each space called for an entry by the surveyor, or else a check-mark indicating that no entry was necessary. With this arrangement, the surveyor could tell at a glance, before picking up his instrument at any station, whether anything had been omitted from his record. Although intended primarily for underground work, the blanks are equally suitable for open-air surveying.

ACTUAL FIELD-NOTES.—Form 1 is the blank for actual field-notes. Each of the three sections into which the page is divided by double horizontal lines, is for the data pertaining to a complete surveyed line. The station occupied by the instrument is recorded at the bottom of the section, and the true course and distance to the next station is recorded in the same section, between the double vertical lines, reading up. If the back-sight does not already show on the page as a preceding surveyed line, it is entered on the same horizontal line as the instrument-station, the arrow, $\frac{BS}{CC} \rightarrow$ or $\leftarrow \frac{BS}{CC}$ being placed so as to indicate whether the calculated course, *CC*, runs from the back station, *BS*, towards the instrument, or *vice versa*.

*Fr. Mag.* and *To Mag.* show the magnetic courses before and after turning the angle at any station. In all cases, *Fr. Mag.* is the magnetic direction from which the angle is turned.

*Angle* and *Double A.* The plate-angle, read from the vernier, is recorded with a prefix, *R*, meaning to the right, or *L*, to the left. Compare this with the angle indicated by the magnetic courses. As a check, double the plate-angle.

*Slope A. C.* is intended as a check on the slope-angle, and is the reading that would appear if the graduations on the vertical arc were counted in the wrong direction from the nearest 10°-mark. For example, if the slope-angle is 18° 46′, then the *Slope A. C.* would appear 21° 14′. Record both readings; the sum of the two is always a multiple of 20°, and the true angle is always the least of the two readings.

*Slp. Dis.*, the slope-distance, is measured from the axis of the instrument, to *O*, the object sighted at. For stadia-work, record here the upper and lower rod-readings; record the middle rod-reading under *H. O.* to *F.*

*Z* is a quantity to be subtracted from the slope-distance to obtain the horizontal distance. It is the slope-distance multiplied by the versed-sine of the slope-angle. The versed-sine of ordinary slope-angles is a quantity having its first significant digit in the second or third decimal place; and with a slide-rule graduated for versed-sines, the horizontal distance may be determined quite as accurately and more quickly than by multiplying with cosines.

*V* represents the vertical distance between the axis of the instrument and the object, *O*, sighted at. It is the slope-distance multiplied by the sine of the slope-angle. In most cases *V* may also be found with sufficient accuracy by using the surveyor's slide-rule, graduated for sines, tangents, and versed-sines.

*H. I. to* is for the height of instrument above the floor, *F*, or to the roof, *R*, as the case may be in mine-surveying.

*H. O. to* is for the height of object sighted at, measured from the floor, *F*, or to the roof, *R*. For stakes and points in surface-work, enter *H. O. to F.*

*Remarks.*—The description of each permanent survey-point is entered opposite the station number. The distances to objects noted along the line may be entered in this column as *plusses* and are to be measured from the instrument-station in each case. All recorded distances to the right or left are understood to be measured from the surveyed line at right angles, unless otherwise stated. Whenever the space in the "Remarks" column is not ample for sketches, use reverse side of sheet or else a second sheet for this purpose.

OFFICE CALCULATIONS.—Form 2 is the blank for office calculations, and if so desired a carbon manifold copy may be made to serve as a duplicate office record. The last two columns are intended for calculations by logarithms. The latitudes, departures, and elevations are recorded opposite the stations to which they belong.

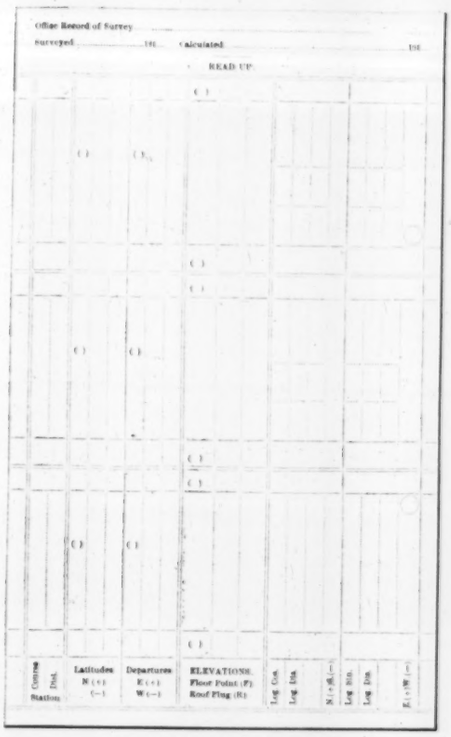
In the surveys herein referred to, all boundary corners were tied to the nearest U. S. land monument, and the origin of latitudes and departures was so chosen that this monument became Latitude N. 5,000 and Departure E. 5,000. By this means, none but positive quantities were needed to express the latitude and departure of any point in the neighborhood.

An underground closure sometimes calls for slight change in the meridian as first carried underground, in which case the latitudes and departures should be recalculated for complete accuracy. With the loose-leaf system, new sheets containing the modified calculations may be interpolated without confusion.

MAPS.—All original maps are made and kept up-to-date in the main office; and being made on indestructible linen, map and tracing are combined in one. Blue-prints on linen are made from the original map for the use of mine-superintendents or foremen, who are free to make additional marks thereon for their own purposes. When a new set of blue-prints is made, the old set is taken up and filed away.

PERPETUATING SURVEY-POINTS.—For perpetuating survey-points, brass screw-eyes, brass nails, and brass tags are used, on account of being non-corrosive. Points are always set overhead if the ground is firm enough. A turned wooden plug, previously soaked in some wood-preservative, is driven into a drill-hole until solid; then the end is daubed over with bright red paint to make it conspicuous; after which a screw-eye, threaded through a numbered brass tag about as large as a silver dollar, is set in the bottom of the plug. If the roof is insecure, a screw-eye is put in a mine-timber overhead, or a nail is driven into a cross-tie underfoot; but the screw-eye or nail always goes through the middle of a numbered tag so as to hold the tag against the wood; this prevents loss of the identifying tag so long as the screw-eye or nail itself remains in place.

The numbers from 100 to 199 were assigned to the first level, from 200 to 299 to the second level—and so on, 100 numbers to each mine-level. Certain numbers out of each hundred were assigned, in turn, for use in one general direction from the main shaft, and the rest for use in the opposite direction. Thereafter, all stopes, chutes, etc., were designated by the number of the nearest survey-station, and all assay-samples, etc., were recorded with similar reference. A sign-board at each




Form 2.—Blank for Office Record.

ore-chute, marked in large figures with the number of the nearest survey-station, made things easier for the bosses and workmen. For example, the mark "636" on a stick of timber delivered at the main shaft would constitute full directions for its delivery on the sixth level, north side, at the station named.

After being in use for more than 15 years, during which period the underground workings of the mine have grown to an aggregate length of more than 25 miles, this simple system of numbering is still satisfying all requirements. To some extent, the feasibility of such a simple system of numbering has hinged on the development of the mine through one main shaft, with levels at regular intervals; while irregular and more varied workings might have called for something more elastic. Wilbur E. Saunders has described "A Reference-Scheme for Mine-Workings*" which has unlimited elasticity as a feature. Between the two extremes, the range is sufficient to satisfy almost any special condition.

Although this paper deals with an elementary subject, I believe that it will be appreciated by every one who has ever had to deal with a set of survey-notes that were worth but little more, in the absence of their author, than the paper on which they were written.

I desire to give to George W. Snow, civil engineer, Salt Lake City, Utah, much of the credit for the system described in the foregoing paper.

*Reprinted from the "Bulletin of the American Institute of Mining Engineers" for April, 1911.

†Salt Lake City, Utah.

*Transactions Am. Inst. M. E. Vol. XXXVII., pp. 128-139.

## Data on Street-Cleaning Efficiency in Berlin.

By RUDOLPH HERING,* M. Am. Soc. C. E.

The condition of the surface of streets not only greatly interests all those who live in cities, but frequently invites attacks upon our city officers for alleged inefficiency and incompetency in keeping them well cleaned. Generally, I think it will be found on close investigation that these officers are doing not only their best, but that they are also doing as well as is practicable under the physical, political and financial conditions controlling their work. When these conditions make it difficult or sometimes practically impossible to satisfy the public demands, we should seek the true and fundamental cause of the difficulty elsewhere.

In order to help our judgment in this matter, let us briefly define these three fundamental conditions.

PHYSICAL.—To have a clean street surface the pavement must be of a kind and must have a sufficiently smooth surface to allow of both effective and easy cleaning. Smooth pavements, such as are made of sheet or block asphalt, of accurately cut blocks of granite (Liverpool) or other stone, of hard and tough brick, of wood, etc., all set on a firm foundation, are much easier and cheaper to clean effectively than our ordinary rough-dressed stone blocks, cobble or rubble pavements, or almost any pavement placed on an infirm or earth foundation, such as we still find in many of our cities.

POLITICAL.—The care of pavements, as regards repairs and cleansing, should be entirely in the hands of a permanent and efficient organization of well-trained and experienced men, especially educated by long service in the specific duties involved. They should be continuously encouraged by rewards for good and better work, rather than discouraged by unwarranted criticism, or discharged without good cause, or fined by penalties for insufficient work.

FINANCIAL.—To maintain clean streets requires a sufficiency of funds to enable the work to be done thoroughly as well as economically. The necessary appropriations to do thorough work are probably never refused by taxpayers, if the public feels that, under a good administration, clean streets can and will be secured.

Among the larger cities of the world there is probably none that is being kept as clean and with less labor and at a less expense than the city of Berlin. The above-mentioned three conditions are perhaps nowhere better fulfilled; the pavements are smooth, the organization is excellent, and the funds are sufficient. It may, therefore, be of interest to some of the readers of Engineering News to read some notes and examine some data, most of which are taken from the Annual Report of the Street Cleaning Department of Berlin for the year 1909, which in part I recently compiled in connection with an engagement relating to the subject, and which I have amplified by explanations and deductions.

The City of Berlin, so far as the following information is concerned, had a population of about 2,250,000 persons and 65 square kilometers of area (16,062 acres). The metric measures of the report have been converted into United States units, and for American use I have endeavored to reduce so far as possible all figures to units of quantity of work and time, independent of wages and cost, so that our own data wherever available can be directly compared, as regards efficiency, with those of other countries, the question of wages being eliminated. And it will be interesting, furthermore, to compare the efficiency of the Berlin street cleaning organization, having the best pavements to work upon, with the efficiency of our own street cleaning organizations, most of which have less good pavements.

Of further interest is the manner in which the force is permanently cared for, not only by proper housing, as local studies reveal, but also by rewards, pensions, insurance against accidents and sickness, care of family, etc. A close observer may see that in some ways the Berlin street cleaner is proportionately better off than his American cousin, who is holding a similar position in some of our larger cities. The lower wage is about proportionate to the lower cost of living.

*Consulting Engineer, 170 Broadway, New York City.

### Street Cleaning Organization and Practice.

ORGANIZATION.—The department is governed by a representative Municipal Board (Deputation) of 12 persons, which, during the year 1909, held five meetings, at which resolutions were passed and handed down for execution to the Director and executive head of the department, who must be present at all of the meetings.

The Director is assisted by a sub-director, 10 chief superintendents or, as they are called, chief inspectors, 68 inspectors, and, at the principal storage depot, by one chief inspector, one inspector, one clerk, 46 mechanics, laborers and chauffeurs, a total of 129 persons in the executive department, excluding the Municipal Board. The administration, therefore, requires one person for 17,442 inhabitants, or one person for 124 acres of paved surface.

For street cleaning purposes the city is divided into 33 districts, each one being in charge of a superintendent responsible to the Director.

WEATHER RESULTS.—Weather conditions, of course, essentially affect the accomplishments of the department and the cost of cleaning. The winter work controls the efficiency, because it generally represents the main part of the annual cost. For instance, the cost of carting the snow varied from M. 1,231,746 ($295,619), in the year 1906, to M. 10,605 ($2,545) in 1893, and the additional labor required to prepare the snow for loading varied from M. 263,115 ($63,148) in 1906, to M. 3,590 ($862) in 1893. During 1909 these two disbursements together were M. 417,866 ($100,288).

PLAN OF WORK AND AREAS.—The department has a "working plan" for the year which is a graphical compilation indicating all of the work required. It contains an accurate classification of all of the streets and of the character of their respective cleaning and forms a rigid basis for all of the outside operations. It contains also an inventory of the areas of all of the streets covered with different kinds of pavement.

On March 31, 1910, the close of the fiscal year, 1909, there was an area of 10,972,664 sq. m. (13,126,080 sq. yds.) of paved area regularly cleaned, of which 6,748,509 sq. m. (8,073,120 sq. yds.) were carriageways and 4,224,155 sq. m. (5,052,960 sq. yds.) were sidewalks.

The total area cleaned daily at the end of the year was 7,145,076 sq. m. (8,547,440 sq. yds.). The increase from the previous year was 77,355 sq. m. (92,444 sq. yds.). The area cleaned daily has grown from 2,708,300 sq. m. (3,237,960 sq. yds.) in 1882, to 7,145,076 sq. m. (8,547,440 sq. yds.) in 1909, an increase of 164%. The annual cost of cleaning in 1909 was M. 6,133,039 ($1,471,929); therefore, the annual cost of daily cleaning per square meter is M. 0.86 ($0.17 per sq. yd.).

The area of street surface including sidewalks cleaned daily per inhabitant is about 3.2 sq. m. (3.83 sq. yds.).

THE RELATION OF DIFFERENT PAVEMENTS TO STREET CLEANING.—During the last year the area of stone pavements has been increased by 32,535 sq. m. (38,916 sq. yds.) so that at present the entire area of stone pavements is 3,334,193 sq. m. (3,988,160 sq. yds.). Asphalt pavement has been increased by 96,112 sq. m. (116,160 sq. yds.), so that the entire area now is 2,953,215 sq. m. (3,533,200 sq. yds.). Wood paving, which finds application here and there for approaches to bridges and upon the bridges, has been increased 3,417 sq. m. (4,087 sq. yds.). At the end of the year there existed, therefore, within the city, 6,410,624 sq. m. (7,667,044 sq. yds.) of the best street pavements.

The area of still existing inferior stone pavements is steadily decreasing and is now confined to the oldest and least used side streets.

WORKING FORCE.—In spite of the enlargement of the territory requiring cleaning last year, it was not found necessary to correspondingly increase the number of workmen.

In 1909 there were engaged in the service of street cleaning approximately 105 foremen, 1,400 workmen, and 529 boys and young men. Altogether, therefore, there were 2,034 persons engaged as a constant working force. Ad[ditionally] there are 11 chauffeurs, 24 mechanics, 4 [foremen,] 7 laborers, 1 stenographer and 103 wome[n pub-] lic toilets.

Assuming a force of 2,050 persons the[re is on-] person to 1,097 inhabitants and one p[erson is] 5,352 sq. m. (6,401 sq. yds.) of pavement r[egularly] cleaned, nearly two-thirds of which is [cleaned] daily.

Of the permanent force, one person cle[aned 3,-] 317 sq. m. (3,968 sq. yds.) of the entir[e paved] street surface, including sidewalks, and [1,012 sq.] m. (4,200 sq. yds.) of the surface which is [cleaned] daily. The area of asphalt pavement da[ily cared] for by boys and young men is 5,583 sq. [m. (6,678] sq. yds.) per capita of force.

WAGES.—The laboring force receives [the fol-] lowing daily wages:

| | | | |
|---|---|---|---|
| *Boys and Young Men:* | | | |
| During the first two years | 2 | mar[ks] | ($0.48) |
| After two years | 2.25 | mar[ks] | ($0.54) |
| After four years | 3 | ma[rks] | ($0.72) |
| *Men:* | | | |
| For the first three years | 3.75 | mar[ks] | ($0.90) |
| After three years | 4 | mar[ks] | ($0.96) |
| After six years | 4.25 | mar[ks] | ($1.02) |
| After nine years | 4.50 | mar[ks] | ($1.08) |
| *Foremen:* | | | |
| For the first three years | 4.75 | mar[ks] | ($1.14) |
| After three years | 5 | mar[ks] | ($1.20) |
| *Chauffeurs* | 5 | mark | ($1.20) |
| *Mechanics:* | | | |
| For the first three years | 4.50 | mar[ks] | ($1.08) |
| After three years | 4.75 | mar[ks] | ($1.14) |
| After six years | 5 | mar[ks] | ($1.20) |

The laborers in the main station are paid the same wages as the street cleaners.

Overtime is paid for at 0.50 marks (12 cts.) per hr. for men and 0.30 marks (7 cts.) per hr. for boys and young men, if the Director finds overtime necessary.

The women attendants at the municipal toilets receive 1.50 marks (36 cts.) per day, and gratuities.

The entire labor force is provided with proper clothing for the service.

In case of sickness every person who has been in the service more than one year receives his full wages for six weeks. In case sickness has been contracted in performance of the service the wages continue beyond six weeks.

FINANCIAL CARE OF THE FORCE.—The legal requirements for insurance against sickness, old age, invalids and accidents were not changed during the past year. Insurance was paid for 22,480 days of sickness in 1,308 cases.

The legal requirements for accident insurance were applied during the year in 42 cases.

GRATUITIES.—Money presents, as rewards for a 25-year service were made as follows:

| | |
|---|---|
| 5 foremen received 90 marks or (each) | $21.60 |
| 3 laborers received 75 marks or (each) | 18.00 |
| A superintendent received 150 marks or | 36.00 |

PENSIONS AND BENEFITS.—During the year, in consequence of permanent disablement caused in the service, four foremen and 13 workmen were discharged and pensioned. Widows and children received pensions in nine cases. Besides the above, there were benefits paid as follows:

| | |
|---|---|
| 3 foremen | 425 marks ($34 each) |
| 41 laborers | 2,045 marks ($12 each) |

WORKING TIME.—The usual working time is nine hours for the day and eight hours for the night. During inclement weather and at other times when necessary the time is increased. These figures do not include any time for lunches, meals or rest.

During the year 1909 the average daily working time of the laboring force was only eight hours. Assuming a working force of 2,050 men working 300 days per annum we have 4,920,000 working hours per annum to keep 13,126,080 sq. yds. of paved area cleaned.

APPARATUS AND MATERIALS.—Apparatus and materials are purchased from parties with whom previous contracts have been made. Small deliveries of material and a small amount of labor are ordered and paid for without competition, but after a previous agreement as to prices by the Director and after the approval of at least three members of the Municipal Board.

DEPOTS FOR APPARATUS AND MATERIAL.—Each one of the 33 street-cleaning

divisions of the department has a superintendent, and a special depot for its own apparatus. It has for some time been tried to utilize city property for this purpose, but not yet with success. In 1909 it was necessary to pay rent in six of such divisions. There is on the average one division for 68,181 inhabitants and for 332,-[illegible] sq. m. (396,880 sq. yds. of streets and sidewalks.

SWEEPING MACHINES.—During the past year, as well as in the previous year, 111 sweeping machines were used, of which 88 were for continuous night work, while 14 were used only during 120 nights, and 9 were held in reserve. The approximate time per annum of machine working is about 180,000 hrs. or one hour is required per annum to keep 38 sq. m. (45 sq. yds.) swept daily. About 10,000 sq. yds. are swept by one machine per hr.

Regarding the durability of the revolving brooms, the following is reported: There were 1,310 sets of revolving brooms used up, indicating that each of the machines in use required about 14 sets that is, every set lasted about 21 working days, or about 142 hrs. of active work. The streets are sprinkled before they are swept. All machines start work every night at 11:30 in all districts, and they work until the prescribed daily task is finished. The amount of this work generally requires from 6½ to 7 hrs. The city hires all horses for street cleaning.

SCRAPING OR SQUEEGEE MACHINES.—During the year no new squeegee machines were added to the service. There were 16 in use.

FLUSHING WAGONS.—The Hentschel flushing wagons, which had been previously secured, were still giving good service during the year and particularly in removing the slippery coating or greasy mud from the asphalt pavement during damp weather. For this reason four more machines were bought so that now 28 are in service.

The tests made during the previous year with this style of flushing wagon, when operated with electric motors, were so favorable that during the last year three more of such wagons were bought, and two of those already in use and drawn by horses were provided with electric motors. Therefore, there were in use at the end of the year six Hentschel flushing wagons with electric motors, and 22 drawn by horses. It is intended to gradually reconstruct all of the remaining flushing wagons and provide them all with electric motors.

REMOVAL OF SWEEPINGS.—The carting away of the street sweepings is done by contract. The annual price for loading and carting is on the average M. 186.20 per 1,000 sq. m. cleaned daily ($37.30 per 1,000 sq. yds.).

In 1909 there were removed by the contractors 168,144 loads, or 336,288 cu. m. (439,872 cu. yds.) of sweepings; therefore, daily, 461 loads, or 922 cu. m. (1,206 cu. yds.). One cubic meter was removed from about 24 sq. m. per annum, or 1 cu. yd. from 22 sq. yds., or a depth of 1.63 ins. per annum. This quantity is frequently double and triple the average, when confined to a few hours, and when caused by a sudden change of weather; for instance, when a sudden rain follows a dry period.

During the year the cost of removal was about 7.45 marks per load, or 3.73 marks per cu. m. ($0.68 per cu. yd.).

The contract for the removal of snow remained the same as in previous years. The contractor was required to hold himself in readiness to have the necessary number of wagons, so that on command the snow which had been gathered into piles could be removed as quickly as possible. The contractor was also obliged to have a sufficient number of proper localities in readiness to receive the snow.

The number of loads was controlled by tickets as satisfactorily as it was in previous years. Street sweepings are not separated from the snow and cannot be counted separately. Therefore, as the contractor, while he is removing the snow, is paid a sum for removing also sweepings, it is necessary to deduct, on the basis of the number of tickets given, the average of street sweeping loads during the months without snow, as obtained from previous experience, in order to ascertain and fix the number of loads of actual snow removal that were to be paid for.

This average number of street sweeping loads was found to be 14,084 loads per month. The number of loads of snow removal after deducting this average resulted during the winter period, 1909 to 1910, in 137,454 loads. One load of sweepings or of snow measures 2 cu. m. (70.6 cu. ft.).

### Snow Removal.

GENERAL.—The winter 1909-1910 began rather early. The first snowfall was on Nov. 17, the period lasting until Dec. 3, 1909, and resulted in an average depth of 13 cm. (5.1 ins.). For the handling of this quantity of snow it was necessary to engage a special force.

Unfortunately the 3,000 extra men required were not available and not more than 1,800 men could be daily secured. Nevertheless it was possible to remove the snow in good time for the traffic, as the 32 snow-plows that were sent out ahead of the wagons were of great assistance.

The snow during the winter was, as previously, discharged into sewer manholes and into public water-courses. Only snow which had become too dirty was carted away to the dumping places provided for the contractors.

The largest number of wagons ordered to be used daily was 1,180, but this number could not always be furnished by the contractors.

As during the previous year, requisition was, therefore, made upon the teams engaged on the sewage-disposal fields. Requisition was also made upon the entire staff of the department. The laborers using large snow wheel-barrows, dumped 23,900 cu. m. (31,261 cu. yds.) of snow into the sewer manholes.

The total cost of snow removal from the streets for this first period, lasting from Nov. 17 to Dec. 3, was about M. 277,170 ($66,521) and the quantity of snow removed was 180,368 cu. m. or 235,921 cu. pds. Therefore, the cost per cu. m. was M. 1.53, or $0.28 per cu. yd.

Assuming that the snow was removed from the area of pavements daily cleaned, or 7,145,-000 sq. m. (8,547,000 sq. yds.) the average depth of snow taken away from a fresh fall of 13 cm. or 5.1 ins. was 0.025-m. or 1 in., the difference indicating the loss by melting and compacting.

On Jan. 25, 1910, the second snow period began, lasting until Feb. 1, and likewise made extraordinary demands upon the department. The total cost of snow removal was about M. 140,-700 ($33,768) and the quantity was 94,540 cu. m. or 123,663 cu. yds. Therefore, the cost per cu. m. was M. 1.49 or per cu. yd $0.27

Assuming again that the snow was removed from the area to be cleaned daily, then the average depth removed from a fresh fall of 6 cm. or 2⅜ ins. was 0.013 m. or ½-in.

It is clear that the quantities of snowfall in Berlin, which is the case in Western Europe generally, are small compared with those common in our eastern cities, and an equally quick removal under our conditions would be almost impossible. During the two periods, which embodied practically all of the snow removal of the winter, there were removed a total quantity of 274,908 cu. m. (360,580 cu. yds.). This quanity was made up of the removal of 221,634 cu. m. (289,-897 cu. yds.) by contractors, of 37,538 cu. m. (49,100 cu. yds.) by barrows with city employees and 15,736 cu. m. (20,583 cu. yds.) by wagons from the sewage farm. The cost of removal by the city employees of 53,274 cu. m. (69,683 cu. yds.) saved the city M. 43,015 ($10,324) from the contractor's price for hauling the same quantity to the regular dumps.

According to the new contracts, beginning April 1, 1909, the cost of removal of snow was computed according to a tariff depending upon certain zones. The cost per cu. m. was made up as follows: (1) the transportation within the cleaning district at 1.25 marks; (2) additional remuneration of .25-mark for every further kilometer upon which hauling had been begun (computed as an air-line from the nearest boundary of the district).

The average cost of snow removal during the last 20 years was about M. 440,000 ($105,600) per annum.

SNOW PLOWS.—During the year six more snow plows were bought (System Hellmers of Hamburg) so that altogether the department has 38 in use. It is intended to purchase 10 more for the following year.

DUMPING SNOW IN SEWERS.—The Deputation had again permitted last year the use of the large brick sewers for the reception of snow, provided the dumping was more than 700 m. distant from a pumping station.

It was found, without causing any disturbance in the flow of sewage, that 53,274 cu. m. (69,682 cu. yds.) of snow could be disposed of in this manner. The manholes for dumping were selected so that only sewers having a large flow were used and during the night-time when the flow in the sewers is comparatively small, the dumping of snow was reduced as much as possible. The additional cost to the sewer department resulting from this snow dumping into the sewers was 12,504 marks ($3,001).

WAGONS OF THE CITY DISPOSAL FIELDS.—The removal of snow was facilitated during the year also by utilizing the wagons of the sewage disposal fields. Accordingly on 11 days 152 two-horse wagons daily, including drivers and the necessary inspectors, were thus employed.

### Street Sprinkling.

SPRINKLING WITH CLEAN WATER.—For street sprinkling 290 one-horse wagons, each holding 1,500 liters (1,321 gal.) contents, with force pump, were used during the year. These wagons were all provided with Miller's patent sprinklers which were more satisfactory than the former pipe sprinklers.

A new contract for the teams and service for the city sprinkling wagons was made April 1, 1909. Accordingly, the contractor gets M. 6.35 ($1.52) for one-day horse service and M. 4.50 ($1.08) for one-day driver service. The maintenance of the machines is paid for by the department.

During the year there were used for sprinkling the streets 1,274,917 cu. m. of water (336,833,-300 gals.) and the sprinkling averaged about 156 days per annum on the entire area. Assuming that 6,748,509 sq. m. (8,073,120 sq. yds.) of streets were sprinkled, it required 41.7 gals. of water per sq. yd. per annum, and as the annual cost, excluding cost of water, was about M. 480,000 ($11,-500), the cost of sprinkling with water was about M. 0.07 per sq. m. ($0.014 per sq. yd.) per annum.

SPRINKLING OF ASPHALT AND WOOD PAVEMENTS WITH A 1% SOLUTION OF WESTRUMITE.—The general introduction of oil sprinkling for asphalt and wood pavement during the past year, particularly with reference to dust and cost, has been very successful.

By the use of oil emulsion for the sprinkling it was possible to discontinue for weeks the otherwise daily water sprinkling without suffering from dust.

Under the assumption of six oil sprinklings during the summer, a sq. m. thus sprinkled would cost M. 0.009 ($.0018 per sq. yd.) per year, while for the sprinkling with city water alone, without computing the cost of the water, the cost would be M. 0.07 per sq. m. (0.014 per sq. yd.) per year.

SPRINKLING OF THE STREETS WITH SOLUTIONS OF CHLORIDE OF MAGNESIUM AND CALCIUM—The use of chloride of magnesium for dust removal during the last year was discontinued, but tests are now being conducted with a solution of chloride of calcium which gives the same good results. As the latter is about 40% cheaper than chloride of magnesium, it has been added during freezing weather to lay the dust, prior to the work of the sweeping machines.

It was, therefore, possible to resume machine sweeping during dry frost, which sweeping had to be otherwise suspended at such times on account of the creation of dust. As the preliminary

sprinkling with chloride of calcium solution not only lays the dust but melts the freezing dirt, this also could frequently be removed by the sweeping machines.

CLEANING OF STREET RAILWAY RAILS.—The charge of the department for a single cleaning of the rails of a thousand running meters was M. 1.15, ($0.44 per mi.). The department received from this source during the year M. 108,370 ($26,009).

SAMARITAN SERVICE.—The employees of the street cleaning service are, in the future, to assist in the life-saving or accident service. Therefore, during the last year all superintendents and foremen were instructed by a specially engaged medical corps in the duties of first help, in the case of any persons meeting with accidents on the street.

ANNUAL COST OF STREET CLEANING.—The expense account for 1909, excluding administration, executive department, pensions, etc., is as follows:

| | | |
|---|---|---|
| Ordinary or regular expenses: | | |
| Wages for regular employees, including motormen and mechanics | M. 2,871,839 | $689,241 |
| Clothing (uniforms) | 51,421 | 12,341 |
| Tools and materials, repairs to motors, wagons, sweepers, snow-plows, etc. | 380,771 | 91,385 |
| Hauling away sweepings, service of sprinklers, etc. | 1,921,313 | 461,115 |
| Depots and stations, rents and sundries | 49,590 | 11,902 |
| Snow removal | 435,820 | 104,597 |
| Pensions, benefits, gratuities, and insurance of tools, motors and sweepers and machines | 16,451 | 3,948 |
| Extraordinary expenses: | | |
| 3 new Hentschel, electrically-driven flushing wagons | 37,500 | 9,000 |
| 2 Hentschel flushing wagons provided with electric motors | 19,000 | 4,560 |
| Sundry new buildings | 345,342 | 82,882 |
| Office repairs | 3,992 | 958 |
| Total | M. 6,133,039 | $1,471,929 |

For convenience of comparison of work done I shall group some of the unit items and a few of the characteristic data relating to Berlin:

Population, 2,250,000.
Topography, almost level, with a small river passing through the city.

| | Sq. yds. |
|---|---|
| Area of carriage ways regularly cleaned | 8,073,120 |
| Area of sidewalks regularly cleaned | 5,052,960 |
| Total area cleaned | 13,126,080 |
| Area of asphalt pavements cleaned daily | 3,533,200 |
| Area of other pavements cleaned daily | 5,014,240 |
| Total area cleaned daily | 8,547,440 |

Area of paved surface cleaned daily per inhabitant ..... 3.8 sq. yds.
*Administration* (excluding Municipal Board), 129 persons.
One person (including inspectors, mechanics, clerks, etc.), for 17,442 inhabitants.
One person (including inspectors, mechanics, clerks, etc.), for 22 acres of paved area.
*Working Force* (including foremen, etc., but excluding drivers and horse service), 2,050 persons.
One person (including foremen, etc., but excluding drivers and horse service) for 1,097 inhabitants.
One person (including foremen, but excluding drivers and horse service) for 6,400 sq. yds. or 1.32 acres of total cleaned area.
One person (including foremen, etc., but excluding drivers and horse service) for 4,200 sq. yds. or 0.87-acre of area, cleaned daily.
One person (including foremen, etc., but excluding drivers and horse service; boys and young men) attends to 6,678 sq. yds. or 1.38 acres of asphalt pavement, cleaned and flushed daily.
One person cleans about 550 sq. yds. per hr. on the basis of 2,050 men at 8 hrs. for 300 days per annum, excluding drivers and horsemen.
Sundries:
One cubic yard of sweepings is taken from 24 sq. yds. of pavement per annum or a depth of 1½ ins. in one year.
One square yard of pavement required 41.7 gals. of water per annum for sprinkling.
One depot for apparatus, office, storage, etc., in each district for 68,180 inhabitants.
One depot for 398,816 sq. yds. of streets and sidewalks.
One sweeping machine is required for 72,000 sq. yds. of street surface.
One machine sweeps about 10,000 sq. yds. per hr.
One squegee machine is required for 221,188 sq. yds. of asphalt pavement.
One flushing wagon is required for 126,324 sq. yds. of asphalt pavement.
One snow plow is required for 212,960 sq. yds. of paved street surface, but intended to be decreased to 169,400 sq. yds.

The above unit work gives excellent results, as every one who visits Berlin can see. But they are possible only when the pavements are easily cleaned and in perfect order, when the administration is efficient and when the working force is well trained and encouraged to do its best by prospective rewards, however small, and by permanent employment.

## Some Observations on Recent Bridge Construction in America.*

By HENRY S. JACOBY.†

RIVETED TRUSSES.—It is surprising to notice how few railroad bridge trusses with pin connections are being built at present. This tendency is not merely due to the decreased cost of foundations and piers or abutments due to the extensive use of concrete which makes the economic span shorter than formerly, but wherever an old pin span can be divided by an intermediate pier without excessive cost, two riveted truss spans or two plate-girder spans will replace it. The length of riveted trusses has been steadily increasing as the shops have changed their equipment and methods, so that the maximum span has passed 400 ft., and spans between 200 and 300 ft. are numerous. Accordingly, pin spans are mainly confined on railroads to crossings of the larger rivers where the interests of navigation require long spans.

The longest riveted truss spans in the United States are those of the new terminal bridge over the *Missouri River* at Kansas City, the span being 425 ft. 6½ ins. [Eng. News, Feb. 17, 1910, p. 200]. The special reason for making this a riveted truss bridge is that one of the spans has a suspended lifting deck in which the stiff suspenders telescope into the hollow posts of the truss. The upper deck accommodates the highway and electric railway traffic, and the lower deck the railroad traffic. The bridge has such an elevation that deck trusses are used over the river in all spans except that of the lift bridge. Since structural reasons required the through trusses of the lift span to be made with riveted connections the same details were used for the fixed spans to secure uniformity. The next in length are those of the reconstructed *Kentucky River High Bridge*, with spans of 353 ft. [Eng. News, April 27, 1911]. The next longest are located in the channel spans of the *Sixth Street Viaduct* over the Kaw River at Kansas City [Eng. News, Sept. 26, 1907, p. 323]. The trusses are also of the Baltimore type, with a span of 300 ft. 10 ins. Next in order come the riveted truss spans of the Idaho & Washington Northern Railroad over the *Pend Oreille River*, at Box Canyon, Idaho, completed in 1910 [Eng. News, Jan. 12, 1911, p. 46]. The channel span is 280 ft. and was erected from one end by the cantilever method without the use of falsework. The adjacent shorter span was used for this purpose as an anchor span.

In Canada the largest riveted truss bridge for railroad traffic has an effective span of 412 ft. 8 ins. It is on the Canadian Pacific Ry. where it crosses the *French River*, 43 miles south of Romford, Ontario. Special conditions also led to the adoption of this unusually long span for riveted trusses. The *Cisco Bridge* over the Fraser River in British Columbia, erected in 1910 on the same railroad, has riveted trusses with a span of 315 ft., which are designed for E50 loading.

PIN-CONNECTED SPANS.—It is worthy of note that the longest span of a pin truss railroad bridge remains the same to-day as in 1893, or 546.5 ft. Only one light highway bridge exceeds this in effective span, with a length of 586 ft. [*Elizabethtown Bridge* over Miami River, Eng. News, Nov. 18, 1909, p. 545]. At present, however, the substructure is well advanced for the new *Municipal Bridge* at St. Louis, popularly known as the "Free Bridge," in which the effective spans are 668 ft., due to the demands of navigation as decided by the United States Government. This bridge is to accommodate the highway on an upper deck and a double-track railroad on the lower deck. It is to be built of nickel-steel and it is proposed to begin the erection this spring [Eng. News, March 16, 1911, p. 320].

Plans are under consideration which make it probable that in a few years the largest span for simple truss bridges will exceed 700 ft.

PLATE-GIRDERS.—The larger live loads now adopted by some railroads tend to increase still further the magnitude of plate-girder construction. The construction of bridges now in progress on the Boston & Albany R. R. for E60 loading includes a plate-girder for a skew span with solid floor which has an effective span of 115 ft. and a gross flange-section of 249.5 sq. ins., exclusive of the equivalent flange area of the web.

RECONSTRUCTION.—A number of prominent bridges are being replaced or reconstructed.

The *Lachine Bridge* over the St. Lawrence River near Montreal is to be changed from a single-track to a double-track bridge using only simple trusses, thus causing the only statically indeterminate continuous truss bridge in the country to disappear. During the past season work was begun in lengthening the piers and in building some additional piers. After completing a new single-track bridge alongside of the present trusses on the longer piers, the old structure will be removed, many of the spans being used elsewhere on branch lines, and a new single-track structure built to replace it.

The Fraser River cantilever bridge on the Pacific Ry. near *Cisco* in British Columbia, in 1884, was removed last year and will be on Vancouver Island on the Esquimalt & Nana one of the operated lines of the Canadian Pa The Cisco Bridge was replaced by three simple tr The middle one with a span of 315 ft., was e the cantilever method, using the side spans as anchor spans. All of the trusses have riveted tions.

The superstructure of the *Coteau Bridge* ove Lawrence River was also reconstructed last ye Grand Trunk Ry. by substituting heavier rivet designed for modern loading. The trusses v on skids on an island, and between trains o old spans was removed by floating it out and a new span put in its place by the sam One of the most interesting features of the sists in the complete elimination of all lac web members of the trusses, exclusive of the The difference in appearance due to this fea parent to an observer at a considerable web members are composed of two pairs of connected by a solid web-plate. This gives with a bulb at each corner of the post, greater resistance to injury in the shops, portation, and in erection. In some cases increased by adding two plates on the o value of the bulb angle in ship building ha recognized, but it appears that the value of of bridge construction in Canada has not been in the United States. [This form of post w the columns of the New York Subway, 1900 is claimed that it has been used in Canada for a number of years with entire satisfaction.

An item of bridge history worth noting is the fact that in 1909 the Grand Trunk Ry. replaced a deck tubular bridge which had been in continuous service since 1855. The excellent quality of the material and workmanship is attested by such long service under steadily increasing live loads.

The old chain suspension bridge over the Merrimac River at *Newburyport*, Mass., built in 1810 and strengthened for electric car service in 1900 was replaced last year by an entirely new suspension bridge of modern design. Because of their historic associations it was at first proposed to suspend the old iron link cables alongside of the new wire cables, but this plan was abandoned for fear of detracting from the handsome appearance of the new structure.

The first cantilever bridge in this country was located on the Cincinnati Southern R. R. (now a part of the Queen and Crescent route) across the *Kentucky River*, and was completed in 1877. At that time it was also the highest bridge in the United States. This bridge was replaced in 1910 by three simple truss spans of the same length or 375 ft. The deck of the new bridge is 31.3 ft. higher than the old one in order to improve the railroad grade. The trusses were erected by the balanced cantilever method from each tower, and without interference with traffic [Eng. News, April 27, 1911].

LARGE NEW BRIDGES.—A new cantilever bridge for highway traffic has recently been built over the Ohio River at *Sewickly*, Pa. The anchor spans are 300 ft. long and the cantilever span 750 ft.

A large steel arch bridge is being erected at present over the *St. Croix River*, seven miles north of Stillwater, Minn., on the Minneapolis, St. Paul & Sault Saint Marie R. R., known as the "Soo line." It consists of five arch spans of 350 ft. each, exclusive of the viaduct approaches. The arches contain one particularly novel feature in design, by means of which the arches have practically three hinges for dead load and temperature, and two hinges for live load. The bridge is 150 ft. high.

Work has been begun on another important three-hinged spandrel-braced arch bridge over the *Crooked River* in Oregon, for the Oregon Trunk Ry. Its span is 340 ft. This railroad is to connect with the Spokane, Portland & Seattle Ry. at the Falls of the Columbia River at *Celilo* by means of a bridge with simple truss spans, which is now under construction.

LIFT BRIDGES.—A number of direct-lift bridges have been built in the last two years and others are now under construction, thus indicating a considerable revival of the type of the South Halsted St. bridge in Chicago, completed in 1894. Previous to that time the type in which a simple span is lifted vertically with the aid of counterweights had only been used for very short spans like those over the Erie Canal.

One span of this type is in the new Mississippi River bridge at *Keithsburg*, Ill., on the Iowa Central Ry. [Eng. News, Nov. 26, 1908, p. 598]. The span is about 230 and the lift about 45 ft. The inclined legs of the towers are connected to the adjacent fixed spans, and in case the river channel shifts the towers may be transferred and another span arranged to lift. Another one completed last year is the *Hawthorne Ave. Bridge* at Portland, Ore., which has a lift span about 244 ft. long [Eng. News, March 9, 1911, p. 279]. The width of this highway bridge is 63 ft. 8 ins. and the vertical lift is 110

Reference has been made previously to the lifting su

*Abstract of an article in "Cornell Civil Engineer" of April, 1911, summarizing the results of an extended leave-of-absence trip over American railways in the latter half of 1910.

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...nded deck of one of the spans in the *Missouri River* ...dge at Kansas City, which gives a clearance of 55 ft. for steamboats. At *Portland* a bridge is under con... ...tion in which a suspended deck is to be lifted for ... ...ls requiring a low clearance while the entire span ... ...ed for higher clearances. At *Chicago* the direct ... ...as been adopted for a skew span on the Pennsyl... ... Lines. The span is about 217 ft. between centers ... ...arings and the vertical lift about 130 ft. Several ... ...examples of this type are located in Arkansas, ... ...and Washington, and during the past year one ... ...ompleted at *Mohawk Place* in Cincinnati over the ... ...and Erie Canal.

...CULE BRIDGES.—Bascule bridges are being built ...ively and their use is no longer confined to lo... ... where it is necessary to avoid encroachment upon ...djacent frontage for docks. They seem to enjoy ... ...special favor of the operating departments of the ...ds.

...CRETE ARCHES.—A large number of reinforced-... ... arch bridges are being built throughout the ... ... both for railroad and highway purposes. The ... ...over *Rocky River* near Cleveland [Eng News, April ..., p. 451] which has the longest clear span in ... ..., or 280 ft., was completed last year. The ... ...spans of the large *Monroe Street Bridge* at Spo... ..., Wash. [Eng. News, Sept. 2, 1909, p. 241] are ... ...by this time. Work on the 281-ft. span was ... ...on account of the accident to the centering, and ... ...to avoid dangers due to high water it was pro... ...to build the new centering on top of a steel truss ... ...designed for another location but temporarily used ... ...purpose.

...bridge of the Boston Elevated Ry. over the *Charles* ... ...at Boston and Cambridge is unique in being the ... ...ch two hinges are employed. Two sep... ...used in each span which support rein... ...ete floor beams. The stringers consist of ... ...ams on which the ordinary type of open bridge ... ...laid, while between the two tracks and outside ... ...there is a concrete slab floor. The spandrel ... ...cover the entire area above the arch ribs between ... ...pporting pillars of the floor beams, but they are ... ...hollow and as light as possible, since they are ... ...intended to carry any live load. Being adjacent to ... ...Charles River Dam special attention was given to ... ...architectural treatment so as to give it the appear... ...of a monumental structure.

A bridge which deserves special mention is that completed in 1910 over the *Colorado River* at Austin, Texas [Eng. News, June 23, 1910, p. 713]. Its total length is about 1,000 ft., and it has eight equal arch spans. The bridge is very simple in design but of excellent form and proportions, while the overhanging sidewalks and its supporting brackets give that distribution of light and shadow which adds so much to the beautiful appearance of the structure.

Another concrete arch bridge of importance is being built on *Kingshighway* in the city of St. Louis. The three large spans are 140, 170 and 140 ft., respectively. On account of the character of the foundation bed it was necessary to adopt an unusual construction to spread the load over a large bearing area by means of reinforced footing slabs, and vertical partitions and sidewalls forming a kind of cellular construction.

More than thirty concrete structures are included in the Hopatcong cut-off each of Delaware Water Gap on the Delaware, Lackawanna & Western R. R., which has been under construction for some time. Among these are two very large arch bridges, the one over the *Delaware River* being 1,450 ft. long and containing more yardage of concrete than any other concrete bridge in the country [Eng. News, Dec. 30, 1909, p. 713]. It has five spans of 150 ft. in the clear, and two spans of 120 ft., beside several smaller approach spans. The *Paulins Kill Bridge* not far distant is 1,100 ft. long, but on account of its greater height and favorable location presents a more impressive appearance than the other.

OTHER CONCRETE BRIDGE-WORK.—Considerable increase is noticeable in the construction of reinforced-concrete slabs supported by concrete pile bents thus forming a trestle on which the regular ballast and track are carried. There are many localities where a low trestle must be used in order to avoid restricting the openings for flood waters. At certain intervals a concrete pier is substituted for a pile bent in order to give additional resistance to longitudinal traction. The Chicago, Burlington & Quincy R. R. has been a pioneer in this type of construction, the Chicago, Milwaukee & St. Paul, Rock Island, Northern Pacific and other western railroads either have built similar structures or have adopted plans for future construction. The reinforced-concrete slab for short openings has been adopted as standard on a large number of the leading railroads of the country. The track elevation of the Chicago, Milwaukee & St. Paul R. R. in Evanston, Ill. [Eng. News, Feb. 10, 1910, p. 158], is notable for its successful application of the slab and ballast deck with intermediate supports on beams and columns on the lines of the curb at street crossings.

The same railroad has made the most extensive development of the hollow abutment. The form most frequently used is the reinforced U-abutment with arched openings on the sides and slab top, the sides being merely curtain walls to support the slabs. The retaining-wall feature is largely eliminated. In the more advanced form arched openings are run in both directions leaving heavily reinforced pillars or columns to support a part of the slab floor.

The heaviest reinforced-concrete beam which has probably been built in this country was observed last November under construction at Tacoma, Wash., where North 23d St. crosses *Buckley Gulch*. The viaduct has seven spans, of which the largest is about 68½ ft. Two beams carry a total width of roadway and sidewalks of 42 ft. and the floor beams are spaced a little over 7½ ft. between centers. The beams in the long span are 6 ft. wide and 10 ft. deep.

The use of concrete piles for the foundations of both bridges and buildings is extending very rapidly. Most of those now in service are of patented forms in which the pile is cast in place after a hole is formed by means of a steel core or a hollow pipe fitted with a point. Frequently the opening is lined with sheet iron to maintain its shape until the concrete is deposited.

In the other class employed the piles are molded in forms and reinforced by longitudinal bars which are tied together at intervals by wire. These piles are driven like timber piles with the aid of the water jet and hammer. Some of the designs are patented while others are not. On railroad construction at least, the piles which are molded, and driven after seasoning, are regarded with increasing favor.

A new development in foundation work consists in building open caissons of reinforced concrete instead of timber or steel. At Black Rock on Niagara River a caisson of this character was successfully sunk in 1910 through 50 ft. of very tough red clay to the rock bottom. The frictional resistance was found to be greater than that heretofore recorded either with or without the pneumatic method of sinking. The caisson was sunk for the pivot pier of the new swing span of the Grand Trunk R. R. bridge, necessitated by the construction of the new lock and canal built by the United States. At Portland, Ore., caissons of a similar type were used for two bridges over the Willamette River, one for the Hawthorne Ave. highway bridge, and the other for the bridge of the Oregon Railroad & Navigation Co., which also accommodates highway traffic. These foundations had to be sunk to a depth of about 120 ft. The great advantage in using concrete in these caissons is that when the sinking is completed and the interior is then filled up with concrete the walls and partitions of the caisson become a permanent part of the substructure.

The use of reinforced concrete in the roof of pneumatic caissons has reduced the amount of timber very materially, and correspondingly reduced the compressibility of the roof when the pier and its load are supported. In the caissons of the McKinley and Municipal bridges at St. Louis, the timber in the roof of the air chamber consists of one layer of 12 × 12-in. and 14-in. timbers, respectively, and a lining of 3-in. plank.

It may be of interest to call attention to the severe test applied by the forces of nature to the reinforced-concrete arches of *Long Key Viaduct* on the Florida East Coast R. R. [Eng. News, Oct. 19, 1905, p. 407, and May 9, 1907, p. 504]. The arches are full-centered and have a span of 60 ft. The top of the spandrel walls is about 30 ft. above mean sea level. Since its construction the viaduct has been subjected to the combined action of wind and waves in the hurricanes of 1909 and 1910. The ocean waves broke over the top and cut out the track filling, but the concrete arches withstood the fury of the storm practically uninjured.

TIMBER TRUSSES.—It is always interesting to find an engineer who is a master in the design of simple structures, especially when the material used is timber. It is unfortunate that so many engineers have regarded the design of many of the details of timber structures as unworthy of their serious study and have turned them over to the master carpenter for solution. For this reason the development of timber design has been materially retarded, while modern conditions have not been adequately met.

In Seattle, the plans were seen of an auditorium in which all the timbers of the roof trusses were connected at the joints by spikes or nails except at the end joint where a casting and bolts were used. Since the structure was intended for temporary use, this method of framing was especially appropriate. The engineer made the design of every detail, however, the plans show the location and size of every spike, with proper spacing and relation to the grain of the wood, and a knowledge of the strength of nails based upon experimental investigation. It is readily appreciated that this method gives cheap and rapid construction.

The same engineer used the same simple details in the design of a truss span which in connection with a trestle was required for construction purposes at a power plant. The bridge had to be built across a deep gorge where falsework could not be used, and the only means of crossing the gorge was a suspension foot bridge that would permit one man to carry one plank across at a time. These unusual conditions were met by using planks and spiked joints in building each half of the truss, and of its connection to a counterweight consisting of a box of sand, then rolling it out on the bank until the projecting cantilevers could be united at the middle. The central span consisted of 10 panels each 16 ft. long, and was designed to carry an electric locomotive and dump cars.

## Selection of Length of Transition Curve.*

By FRANK H. CARTER,† Assoc. Mem. Am. Soc. C. E.

In fixing the alinement of a projected fast interurban electric railway, the writer was confronted with a dearth of information concerning either theory or practice for rigorously selecting proper lengths of easement or transition curves. The only line of thought or suggestion on the subject which could be found was that outlined by Prof. Talbot in his work on the transition curve, and that appeared to be more or less specially applicable to his particular spiral. As spirals of the Searles type had been adopted and were in use on the road in question, it seemed inadvisable to make any radical change in the type of easement curve. None of these standard easement curves, however, were of a length greater than 100 ft., while the theory which is presented herewith demands lengths up to and in some cases exceeding 300 ft.

While the writer was engaged in an attempt at a rigorous solution of the problem, there appeared a very creditable report of the Committee on Track of the American Railway Engineering Association (Bulletin 108) with a principle, new to the writer, from several of the roads; namely, a length of curve dependent upon the rate of rise of the outside of a train on a curve (at the rail) in inches per second.

The rate of rise of superelevation on easement curves is largely, if not entirely, a question of its effect on passengers as to whether the rapidity of vertical rise of one side of the train produces a disagreeable sensation. An attempt to formulate the proper length of transition curve from the rate of rise of rail in inches per 100 ft., without regard to the speed of the train, is approaching the problem from the wrong standpoint. In any formula of type $l = C\ D\ V^2$ the constant $C$, as will be shown, fixes the rate of rise of superelevation of rail; therefore, but one curve and one speed will satisfy this equation in regard to rapidity of rise of train in inches per second. All other curves or speeds will convey different sensations of ease of riding to the passenger. The average rate of rise of the outside of the train (at the rail) in inches per second should be the governing function for the determination of the length of transition curve, as will be discussed a little later. In fixing alinement, smoothness of riding is all important for comfort; hence, the same rate of rise of superelevation on curves in inches per second should govern for the entire road, where a schedule can be predicted with any degree of certainty, a difficult matter, of course, in most cases for new roads, but almost always capable of realization in realinement, when time tables are established.

It appears to the writer that the provision that "the length of the curve should not be less than thirty times the elevation in inches for the ultimate speed" (literally meaning that no rise of superelevation shall be greater than 1 in. in 30 ft.) is a wise one for places where the speed cannot be predicted, but that is not the best practice, in that the rate of rise of transition will not in that case depend upon the speed of the train.

The last clause of the paragraph for the "Manual of Recommended Practice" of the American Railway Engineering Association, concerning the length of easement curve: "that the curve should not be less than two-thirds the ultimate speed in miles per hour times the elevation in inches," places a more rapid rate of rise of the car in inches per second than has been considered best practice for steam roads, according to available information in the hands of the writer. By this rule the rate of rise would amount to about 2.37 ins. per sec., while practice appears to be from 1¼ to 1½ ins. per sec. rise.

The length of easement curves used on the Cleveland, Cincinnati, Chicago & St. Louis Ry. is apparently based on an assumed rate of rise of 1¼ ins. per sec., and the practice of the Delaware, Lackawanna & Western Ry. is given as 1½ ins. per sec.

It is true that cases may be cited where faster rates of rise have been used; notably, a local fast urban electric railway has several spirals where the rate of rise is 1 in. in 20 ft., corresponding to 2.20 ins. per sec. vertical rise at 30 m. p. h.

These curves are said to be easy riding from the standpoint of electric road practice, but jolts and roughness of riding which might be tolerated by passengers on an urban electric road or an elevated road, would not be considered good practice for steam roads.

*From an appendix to the report of the Committee on Track, presented at the annual meeting of the American Railway Engineering Association, at Chicago, March 21, 23.

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## A Traction Rock Drill for 5-in. Holes 50 ft. Deep.

A remarkable innovation in rock-drill construction which was described in our issue of Dec. 2, 1909, provided for the drilling of large deep holes and the saving of time by using long drill rods and making the machine self-propelling. This machine has since been developed to a higher stage of perfection and merits further attention at this time.

Rock excavation in construction work or in quarries producing crushed stone can be accomplished to better economic advantage by heavy charges in deep holes than by lighter charges in the holes driven by ordinary tripod drills. A test recorded in our issue of Jan. 6, 1910, showed that with 275 lbs. and 226 lbs. for the charge in 4-in. holes 40 ft. deep the cost averaged 13.7 and 16.8 per cu. yd. of broken material for two sets of tests; the cost includes the drilling and powder. The larger drill also effects a considerable saving in time by reducing the number of times for changing the drill steels, while if mounted on a self-propelling frame it greatly reduces the time occupied in moving and setting the machine. Well drills or churn drills have been used extensively for putting down large and deep blast holes, and such machines (and their work) have been described in our issues of April 12, 1906; March 11, 1908, and July 15, 1909. But Mr. C. H. Locher, of Thorice, Mich., has invented and introduced a traction rock drill which can put down a 5-in. hole to a depth of 50 ft. This machine has been perfected on the work of excavating the Livingstone deep-water channel in the Detroit River; this work was described in our issue of Dec. 17, 1908, and Mr. Locher is a member of the contracting firm which is carrying it out.* The machine now used was built by the Sullivan Machinery Co., of Chicago, and the following description of the machine and its work is condensed and rearranged from an article by Mr. George H. Gilman in the publication "Mine and Quarry," which is issued by this company.

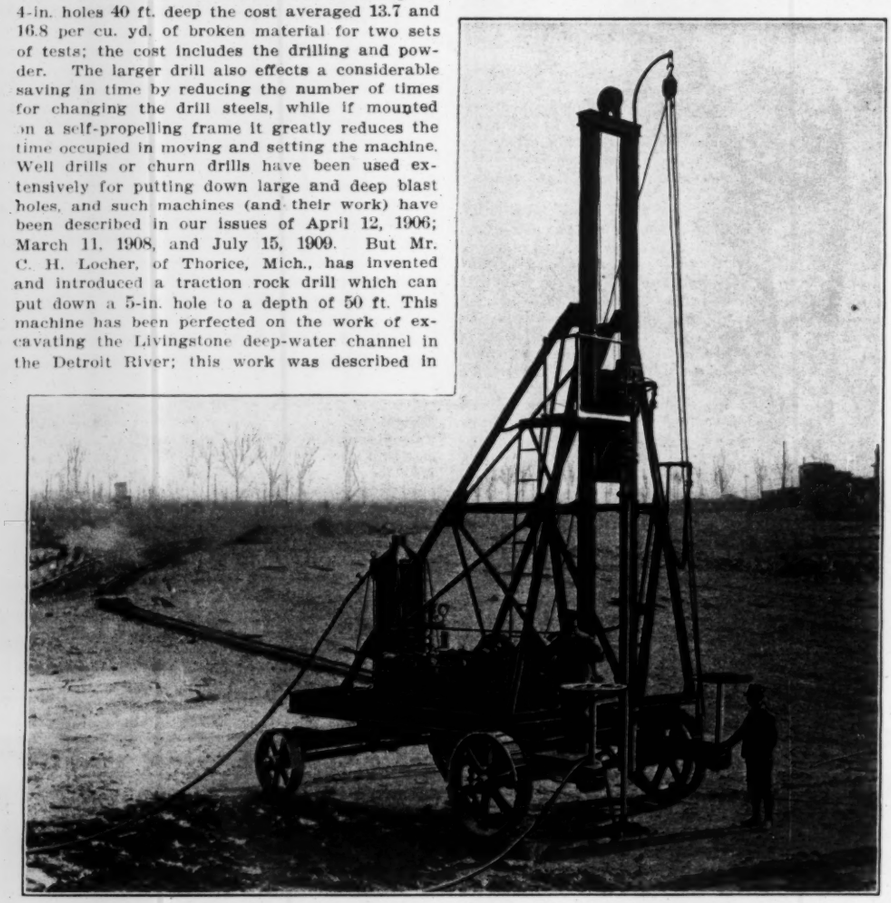

FIG. 1. A TRACTION ROCK-DRILL CAPABLE OF DRILLING 5-IN. HOLES TO A DEPTH OF 50 FT.
C. H. Locher, Thorice, Mich., Inventor; Sullivan Machinery Co., Chicago; Builders.

In quarries for crushed stone and in many engineering undertakings, economical rock excavation requires the drilling of deep blast holes, of large diameter, to accommodate heavy charges of explosive. These holes, in current practice, range in depth from 15 to 50 ft., and from 3 to 5 ins. diameter at the bottom. They are drilled principally with large tripod drills, 3⅝ to 5½ ins. cylinder diameter, with a derrick or tripod of wood or pipe to handle the heavy steel rods.

Three difficulties arise in using machines of this pattern: (1) They are cumbersome and hard to move from one hole to another; (2) much time is lost in changing drill steel, since the range of feed does not exceed 2½ or 3 ft.; (3) the deep holes are hard to keep free from mud and sludge, so that the force of the drill's blow is partly lost by cushioning on mud instead of striking fresh rock at each stroke. The result of these handicaps is that a comparatively small proportion of the total working time is spent in actual drilling. Two of these difficulties, those of transportation and of changing steel, have been solved by the use of traction well-drill outfits or churn drills. These machines have been employed with some success in railway work in Pennsylvania and in the Canadian northwest, on the Panama Canal and elsewhere. The difficulty of cleaning the holes persists in this type, and is a considerable impediment to efficient work.

It was with these considerations in mind that Mr. C. H. Locher undertook, about two years ago, to devise a blast hole driller more rapid and efficient than any machine then available. Grant Smith & Co. and Locher are the contractors for the excavation of the Livingstone Channel, in the Detroit River. This channel will be 300 ft. wide and about one mile long, with a normal depth of water of 21 ft. The area was first enclosed by cofferdams and pumped out; then steam shovels and traveling cableways removed the over-burden in the usual manner, leaving a rock cut to be made from 12 to 20 ft. in depth.

The walls of this rock cut are being channeled in one or more lifts. The rock between is then drilled by 3¼-in. tripod drills driven by air, and broken by blasting to sizes suitable for the shovels and conveyors. With these drills, an average eight-hours' work, including all delays, moving from hole to hole, et cetera, is about 40 ft. of 3-in. hole. The rock is a soft limestone, turning to dolomite with depth, and easy to drill, except for the presence of joints and seams, which tend to throw the holes out of alinement and make proper "mudding" or cleaning of the holes rather difficult.

The machine which Mr. Locher has invented to replace the tripod drills, is shown in Fig. 1. It consists of a vertical standard or carriage, carrying a rock-drill cylinder attached to a heavy iron block, which is suspended in guides or ways over 20 ft. in length by a steel cable, which passes over a sheave and to a hoisting drum. The standard and hoist are mounted on a steel truck. A two-cylinder reversible engine provides power for the hoist and for moving the outfit from place to place, by means of a chain drive to the axle of the rear wheels, above which the standard is mounted. The front wheels swivel to permit steering. The truck carries an air reheater or a boiler as required, and jackscrews are provided at the rear end for taking up motion wh[ile] drilling is in progress.

This outfit enables holes to be drilled to a [dep]th of 20 ft. without change of steel, and in this [case] it is possible to drill 100 ft. without materially du[ll]ing or wearing the gage. The traction feature cut[s] down to a few seconds the time required for changing [from one] hole to another. The work of cleaning the ho[les] is accomplished by an entirely new device, which will be described later.

### The New 50-ft. Traction Drill.

In the summer of 1910, work was encounte[red which] necessitated the drilling of holes to the depth [of 20 ft.] Mr. Locher decided to have built a new mach[ine incor]porating all the features which were found to [be advan]tageous in the earlier machines [noted below] [in]cluding a vertical range of feed for the drill [exceeding] 20 ft., and capable of drilling 5-in. holes at [a rate of] 12 ins. per min. in the limestone of the [Lime]stone Channel. The order for this outfit was gi[ven to the] Sullivan Machinery Co. and the machine wa[s delivered] late in the fall of 1910.

This outfit (Fig. 1) is capable of drilling [holes to a] depth of 50 ft. The mounting is arranged [to move] backward or forward at a speed of 20 ft. per [min.] hoisting speed for raising the drill and weig[hts] per min. The rig stands about 31 ft. high, [21 ft.] long and 12 ft. wide, and weighs 33,000 lbs.

The horizontal frame, built entirely from [structural] steel, is mounted upon four wide-tread st[eel] wheels, those in front being swiveled for steering, [while those] at the rear are on a fixed axle. A shaft, gear[ed direct to] the engine through jaw clutches, carries [two small] sprockets on either side, which are conne[cted by a] sprocket chain to larger sprockets secured [to the rear] or driving wheels for moving the outfit. Directly over the rear wheels is the vertical standard, composed of channel irons, securely braced to the frame of the machine, and serving as a guide for the drill. Forward of this, mounted upon the frame, is the hoisting and propelling mechanism with its two cylinder, reversible engine, while over the front wheels is mounted an air re-heater, through which the compressed air passes to supply both the engine and drill. It will thus be seen that the greatest weight is directly over the rear wheels. Jack-screws are provided at the rear of the frame, which may be set down upon the rock to give the entire machine stability in a lateral direction while drilling is in progress.

The feeding of the drill is accomplished entirely by a suspended weight, to which the drill cylinder is bolted and which provides stability for it. A slow retrograde movement of the hoisting drum for lowering is given by worm gearing, while the hoisting is accomplished by a train of spur gears which connect the main shaft of the engine (through a jaw clutch) with the hoisting drum. An automatic locking arrangement is provided between the hoisting drum and its gear, which prevents any possibility of the drum slipping. With the worm gear in mesh, both hoisting and lowering may be accomplished on the slow speed, while with the spur gears the drill may be hoisted only. No brakes of any description are employed and the speed at which the various devices operate is controlled entirely by the engine throttle. The engine runs continuously while the drill is being fed at any desired speed. Every movement of the machine is controlled by levers from the operators' platform at the rear, and located in such a way that each is accessible and convenient for the operator. One of these levers controls the power steering mechanism.

When starting a hole the drill steel is guided by a hinged clamp fastened to the lower end of the standard, and through which the drill rod reciprocates. After the steel has cut to a depth slightly over the length of its stroke, this clamp is disengaged and swung out of the way, where it remains until the hole is bottomed.

A davit, with block and tackle, at the top of the standard, provides for handling the long lengths of drill steel, in connection with a winch on the main shaft of the hoisting engine.

The outfit was installed temporarily in the crushed stone quarry of the Church Quarry Co. at Sibley, Mich., pending the resumption of work on the Livingstone channel in the spring. At Sibley, the drill has drilled holes to a depth of 44 ft. in rapid time, and the pump steel is entirely successful in handling sludge from holes of this depth. It is estimated that as a means for breaking ground, this outfit, run by two men, will do the work of five tripod drills, requiring ten men for their operation, and that it will accomplish a considerable saving in powder, owing to the larger diameter of the holes drilled. The economy in motive power will also be an important factor. The writer's acknowledgments are tendered to Mr. C. H. Locher for data and suggestions.

### The Rock Drill Proper.

The drill proper used with the Sullivan auto-tract[ion] drill (Fig. 2) is an entirely new development in rock-drill practice. The cylinder is 7 ins. diameter, with a piston stroke of 8⅝ ins. Important changes have b[een]

*Grant Smith & Co. and Locher, Thorice, Mich.

incorporated in it to handle the heavy lengths of steel, and to secure at once, speed, economy of power, and adaptability to the rock and other working conditions. It may be described as a combination of the standard drill and the chopping engine of the Sullivan direct-acting channeler.

The channeler valve and piston motion have been adopted to secure economy, by using the air or steam expansively. The main valve is air-thrown, but is controlled by a reverse valve mounted on the stem of a cut-off valve, which in turn is actuated by a lever in direct contact with the piston, so that the point of cut-off during the length of the stroke may be automatically regulated. Corliss valves in the exhaust ports provide a cushioning effect and prevent damage to the cylinder in case the drill should run into a mud seam or pocket.

The usual method of rotation is employed, except that instead of boring out the piston to make provision for the rifle bar, the rifle bar is made a part of the piston by cutting the flutes upon a projection from the rear of the piston head. To eliminate cylinder wear, a guide bearing for the rod is provided by an extension from the cylinder proper, carrying a removable bronze bushing through which the piston rod reciprocates. This is one of the most valuable features about the machine, as it reduces cylinder wear to a minimum. This wear would otherwise be very pronounced when handling the long lengths of steel.

The drill is lubricated by an automatic oiling device, located in the upper head, controlled by the pulsations of the air in the cylinder. The chamber holds about one quart of oil.

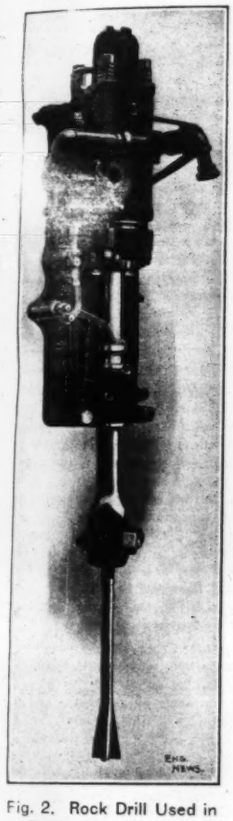

Fig. 2. Rock Drill Used in Drilling Deep Holes.

### Drill Rods for Pumping Mud.

When drilling in this "blocky" formation the chief difficulty encountered with the tripod drills, as noted above, was the extraction of cuttings from the hole as the depth increased. This was due not only to the broken condition of the ground, but seams were often encountered which led to the opening made by a previous blast. After many devices and special kinds of steels had been tried without success, the idea of using the movement of the drill steel for direct pumping suggested itself, and upon trial gave good results. The device employed for this purpose by Mr. Locher is shown in Fig. 3. The drill steel (A) is cruciform in section, and over this is shrunk a tube (B). The bottom of this tube is made in the form of a cage (C), carrying four ¾-in. steel balls (D) which act as valves. One of the cages is shown removed from the drill rod. When the drill steel is thrown downward, these balls are raised from their seats by the resistance of the mud in the bottom of the hole, and a quantity of the sludge is thus thrown above them. When the steel is raised, these balls are naturally dropped to their seats, thus preventing the entrapped sludge from escaping, and the rearward stroke of the drill is sufficient to throw the cuttings out of the top of the tube, where they are deflected downward by a saucer-shaped plate securely fastened to the shank of the steel.

Difficulty was at first experienced in securing the tube to the drill steel. This, however, has been largely overcome by rolling the steel with corrugations into which the tube is rolled by a special process. The valve cages are then inserted in openings cut in the lower part of the tube directly opposite the grooves in the steel, and are held in position by an outer sleeve (E). With this device no difficulty was encountered in keeping the hole clear of its cuttings and even in broken ground little trouble was experienced in keeping the bit free.

When drilling with this arrangement, it is absolutely necessary to have a good stream of water running into the mouth of the hole. To prevent the cuttings from finding their way back into the hole, it is customary to use old sacks, held in place about the mouth of the hole, by stones. To clean the hole after it has been drilled to the required depth, preparatory to loading for firing, or to regain the proper alinement in a deflected hole, it is merely necessary to throw the drill on to a cushion provided for this purpose. It will then reciprocate for nearly a full stroke without striking either head, and thus pump out any loose material which may remain in the hole. This system of drilling has been patented by Mr. Locher in this and foreign countries.

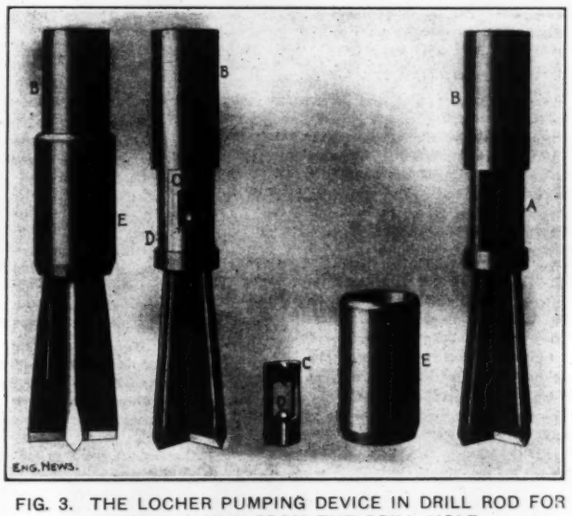


FIG. 3. THE LOCHER PUMPING DEVICE IN DRILL ROD FOR REMOVING MUD FROM THE DRILL HOLE.

### Earlier Traction Drills.

The outfit illustrated in Fig. 1 was not perfected all at once. It is the third which has been built to Mr. Locher's plans. The first rig was built of heavy timbers and carried a drill 5 ins. in diameter, in guides providing a travel or depth of hole of 8 ft., without changing steel. This served its purpose admirably, for it demonstrated that an arrangement of this kind was practical. [It was described in Engineering News, Dec. 2, 1909.—Ed.]

In drilling to the required depth, however, two changes of steel were needed for each hole, and the time required to make the changes was found to be a large percentage of the total consumed in bottoming each hole. Furthermore, it was found that by drilling larger holes a given amount of rock was broken to steam shovel size with fewer lineal inches of drilling, and that there was a marked saving in the amount of powder used.

This first machine, crude as it was, worked steadily for several months, and made some interesting records. On one occasion, 29 ft. of 3-in. hole were drilled in 55 mins., including four moves, occupying about 45 secs. each. In an hour's run, with dull steel and low air pressure, 37 ft. 3 ins. of hole were drilled, with five moves. In 32 mins. three holes were drilled, 6 ft. 2 ins., 7 ft. 2 ins. and 7 ft. 2 ins. deep, and the rig was moved three times. The first of these three holes was drilled in 5¼ mins. Moving, from the time one hole was finished until the next was started, occupied just 2 mins.

This success led Mr. Locher to design and build another machine of more substantial construction, with a 14-ft. feed, on which was mounted a Sullivan drill, with a 7-in. piston, capable of drilling holes to the required depth with a 5-in. bit. With this machine remarkable work was accomplished, and a drilling speed of 12 lin. ins. per min. with a bit of this size was by no means an uncommon occurrence.

SOME FAST DRILLING.—In July, 1910, this second machine worked 28 eight-hour shifts and put in 3,282 ft. of holes, averaging 11 ft. in depth. This gives an average speed of 117.2 ft. per shift for 5-in. holes, as compared with 39 ft. per shift for the 3¼-in. tripod drills drilling 3-in. holes. The 28 shifts included 31 hours of lost time, moving away from shots, changing water lines and other delays caused by limited space, low-working faces, etc. It drilled 75 ft. in three hours, 165 ft. in 7½ hours, and 145 ft. per day for five consecutive eight-hour shifts.

To emphasize the economy in time of long runs without changing steel it may be noted that a Sullivan 3⅝-in. drill, mounted experimentally on a quarry gadder standard, bored 584 ft. of 3-in. hole in six days. The length of the standard permitted holes 6 ft. to be drilled without change of steel. The machine was new and the men unused to handling it. Both this and the auto-traction drill records mentioned above, were made with the use of the pump steel. The following detail record shows the saving in time accomplished by the use of pump steel, and by increasing the length of the feed.

On Oct. 26, 1910, two sets of records were taken. The first was made with a Sullivan 3⅝-in. drill, mounted on a gadder frame, with a small hoisting engine to raise and lower the steel, and using the Locher pump steel. The leads permitted holes to be drilled 6 ft. deep without changing steel. The results are shown in Table I.:

TABLE I.—DRILLING WITH LOCHER APPLIANCES.

| Hole No. | Depth, ft. | Changing steel, mins. | Drilling, mins. | Total mins. |
|---|---|---|---|---|
| 1 | 8 | 6 | 12 | 18 |
| 2 | 8 | 5 | 8½ | 13½ |
| 3 | 8 | 3½ | 9 | 12½ |
| 4 | 8 | 4 | 12 | 16 |
| 5 | 6 | .. | 10 | 10 |
| Total | 38 | 18½ | 51½ | 70 |

Six holes were then put in by the same drill, using regular steel, and pumping the holes by hand. The regular feed screw, 2 ft. long was employed, so that the steel had to be changed once in 24 ins. The results are shown in Table II.:

TABLE II.—DRILLING WITH ORDINARY APPLIANCES.

| Hole. | Depth, ft. | Drilling, mins. | Total, mins. |
|---|---|---|---|
| 1 | 8 | 14½ | 42 |
| 2 | 8 | 24 | 52 |
| 3 | 8 | 14 | 52½ |
| 4 | 8 | 18½ | 57½ |
| 5 | 8 | 13 | 32 |
| 6 | 6* | 42 | 49 |
| Total | .. | 126 | 225 |

*Bad hole.

The time for moving from hole to hole was not considered in either case. It will be noted that if the length of feed in the first record had been 8 ft. instead of 6 ft., 18½ mins. would have been saved in drilling 38 ft.

It will be seen from these two records that with the pump steel and long feed, the rate of drilling was 1 ft. in 1.35 mins.; with the regular steel and usual feed (ordinary tripod drill methods) 1 ft. in 4.89 mins. That is, with the same labor and in the same time the improved method accomplished 3.62 times as much work as the old or standard method. [The new and improved machine which has been described above is expected to show still better performance.—Ed.]

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IF THE PROPOSED ROGER WILLIAMS STREET as planned by Mr. John R. Freeman, M. Am. Soc. C. E., is built in the city of Providence, R. I., that city will at last have found a solution for a transit problem which has bothered it for a hundred or more years. No less than 48 other plans have been proposed at various times for the same purpose. The problem is similar to those which Seattle and other hilly American cities have faced in providing thoroughfares with reasonable grades between busy parts of the cities. At Providence the civic center is separated from the eastern part of the city by the East Side hill, whose steep side renders traffic, particularly street car traffic, difficult and dangerous. The plan which Mr. Freeman, as Engineer for the Municipal Commission having this matter in charge, has prepared, may be briefly stated as follows: A broad highway, 90 to 100 ft. wide, would be built from the space in front of the post-office at Washington St. nearly due East, following in a general way the present location of Angell St., to the junction of Brown and Angell Sts., a distance of nearly 2,000 ft. Starting at an elevation near the post-office of 11 ft. above sea level, the new street would be carried over Canal St. on a concrete arch, through the lot now occupied by the Arnold Block and over North Main St. on another concrete arch to Benefit St., which is crossed at grade. The present Supreme Court Building is here directly in the path of the proposed street and would have to be moved or torn down. At Congdon St. and Defoe Place, North, grade connections with the proposed street would be made. Beyond this point a deep cut would carry the proposed street under Prospect St., which would cross on a broad high concrete arch. The next street, Brown St., would be met at grade at an elevation of 130 ft. above sea level, making the grade for the proposed street about 6%. The estimated cost of the improvement is $1,350,000.

## A Court Decision as to the Enforcement of the Time Penalty in Engineering Contracts.

An important class of litigation over contracting work is that which includes disputes as to a bonus and penalty for completion of the work before or after the date prescribed by the contract. An interesting case of this kind has been passed upon recently by the Appellate Court of Illinois, in reviewing (and reversing) the decision of a lower court.

The case in question relates to the construction of the emergency butterfly dam of the Chicago Drainage Canal, which is placed in the channel leading to the power plant and lock at Lockport. This structure is a steel gate revolving on a central vertical pivot, and was described in our issue of July 22, 1909. The contract was awarded by the Sanitary District of Chicago to the Strobel Steel Construction Co. on July 25, 1906; it required the contractor to commence work within 15 days and complete it (so that the dam could be closed) by March 1, 1907. The contract included the necessary concrete work of the floor, piers, abutments and side walls, but this part of the work was delayed by the failure of another contractor to complete the necessary excavation at this point and in the adjacent part of the channel. Eventually this excavation was taken away from the latter contractor, and was completed by the Sanitary District by day labor. During this work, the work for the contract on the dam was delayed by the blasting and clearing of debris and the men were in more or less danger from the blasting. Floods also caused delay, and there were further delays in the completion of the steel-work plans by the District, which of course hindered the preparation of shop drawings.

On the completion of the dam (about four months after the prescribed date) the contractor offered to accept the amount of the contract without demanding any damages due to interference and delays caused by the District, provided that the district on its part would agree not to demand a penalty for the delay thus caused. Such a settlement was recommended by the engineer, and we are informed that it was favored by a number of the members of the Board of Trustees and even by the legal advisers of the District. One reason for this was that the District was not ready to use the dam when completed, so that it had sustained no damages by the delay. Eventually, however, a majority of the Board of Trustees decided to carry the matter to the courts, partly for the purpose of impressing other contractors with the idea that delays in their work would not be overlooked.

The case went first to the Municipal Court, where a decision was rendered adverse to the contractor. An appeal was taken, with the result that the Appellate Court reversed the decision and pointed out numerous errors in the proceedings of the lower court. The general result of the decision is to indicate that penalty for delay cannot be enforced when the contractor has been delayed by the action or interference of the owner, especially when the owner cannot show actual damages resulting for such delay beyond the contract time. In this case the site was not given to the contractor entirely free from obstructions until after the date by which the contract should have been completed.

The substance of the decision (delivered by Justice Smith, the Presiding Justice) is given below, but we omit the specific references to the errors of the lower court.

The plaintiff, Strobel Steel Construction Co., appellant in this [Appellate] Court, brought an action in the Municipal Court of Chicago against the Sanitary District of Chicago, to recover a balance alleged to be due for the construction of a dam known as the "Emergency Butterfly Dam" located in the drainage canal of the Sanitary District of Chicago. The plaintiff claimed a balance due on the contract appearing by the final certificate of the engineers, amounting to $12,915, and in addition thereto damages occasioned by various acts of interference of the defendant with the execution of the contract by the plaintiff, thus causing delay and expense to the plaintiff in completing its contract.

The contract under which the dam was constructed was dated July 25, 1906, and by its terms the plaintiff agreed to begin work within 15 days after the execution of the contract and to complete the main structure of the dam so as to be able to move and close it by March 1, 1907. For a failure on the part of the plaintiff to complete the work on that date, it was agreed that the plaintiff should pay $100 per day. The defendant claimed, however, that the completion of the dam proper was delayed by the plaintiff until about Aug. 1, 1907, and that the defendant thus became entitled to offset the liquidated damages or penalty of $12,000 against the plaintiff's claim.

The bid of plaintiff for the construction of the dam was accepted on July 25, 1906. The exact location of the dam had not been fixed upon and determined at the date of the contract, and it appears from the record that it was not until July 31, that the exact location of the dam was determined by Mr. Randolph, Chief Engineer of the Sanitary District.* When the site was thus fixed upon, a considerable portion of it was still unexcavated and not cleared by the Sanitary District; some of it was still covered by the solid rock which had to be blasted out, and over other portions of it was strewn loose rock, which had been blasted out and not yet removed. The workmen of the Sanitary District were engaged on portions of the site in loading and removing this earth and rock.

It appears from the record that although the site was thus fixed and determined upon on July 31, 1906, it was not marked and staked out so that work could be commenced until a later date. Under the contract, it was for the engineers of the Sanitary District to furnish lines, marks and grades for all parts of the work included in the contract, so that the location of the various parts could be definitely ascertained and determined before work should be started. This was done from time to time after July 31, 1906, as the site was gradually cleared by the Sanitary District. The site of the south pier was staked out on Aug. 24 and that of the center pit on Aug. 25. The site of the north pier was cleared and staked out somewhere from Oct. 26 to Nov. 7, 1906, although blasting was still going on in the breast rock in close proximity to this pier at this date and for some time afterwards. The site of the east abutment was staked out about Nov. 1, and that of the west abutment about Nov. 27, 1906. The site of the west abutment was not cleared at the time it was staked out, and the portion of the solid rock which impinged upon this site and also upon the site of the tunnel, under the northwest quadrant, was not removed until early in March, 1907.

As originally planned, a tunnel was to be built underneath the channel, extending from the west shore straight across to the north abutment. This tunnel was to have a shaft at each end, and was large enough for the purpose of communication between the shore and the parts of the dam located in midstream. Shortly after the work was begun it appears that the location of this tunnel was changed, so as to run diagonally from the north pier to the west abutment, and through the site of the west floor.

The removal of the rock at the site of the west abutment and the northwest quadrant was not completed until April 20, 1907. The work of concreting the west floor of the tunnel could not be completed until this rock had been removed and the site cleared. This, it will be noted, was after the date fixed by the contract for its completion, March 1, 1907. That is to say, that while the plaintiffs were under contract to complete the entire work by March 1, 1907, a portion of the site, according to the evidence, was not cleared, ready for the work, until a month and 20 days after that date. The work of erecting a steel superstructure necessarily waited upon and followed the excavation and concreting.

On the trial of the case there was no dispute as to the amount which would be due the plaintiff in case no penalty was assessed for delay under the clause in the contract. It was agreed upon the trial that the amount of the reserved percentage in the hands of the defendant on previous certificates, due and unpaid to the plaintiff, was $3,223. The final estimate of McCartney, Assistant Engineer of the District, dated Dec. 12, 1907, shows a balance due on that date of $6,003. In addition to this it was admitted by counsel for the defendant that there was due and unpaid for extra work and material furnished under the contract the sum of $3,688, making the total amount due on the contract and for extras $12,915. The amount of the verdict was $4,665.

As the only defense offered in the court below was based upon the clause of the contract providing for liquidated damages of $100 per day, the difference between the amount of the verdict and the amount due to the plaintiff according to the certificates of the engineers and the agreed amount for extras can only be accounted for by the allowance by the jury of substantially $100 a day for 82½ days to the defendant damages.

The evidence in the record tends to sup... above stated, and that the plaintiffs were ...layed in the delivery to them of the site ... the dam was to be erected. There was not ... in delivering the site properly marked and ... but there was some delay in the location of ... the dam itself, according to the testimony; an... location was made, there was a change made ... cation, and a change made in the course of ... as above indicated. The defendant, Sanita... continued to occupy part of the site after the ... for the plaintiff to commence work, and ... time that the plaintiff was at work upon por... site of the dam, and also in connection with ... cution of its work in completing the contr... ately adjoining the site.

The plaintiff contends, and we agree with ... tion, that the contract and the work requ... done thereunder was an entirety, and that the ... the plaintiff was to receive the site was the ... vided for in the contract when it was to com... work; and that it did not receive the site ... contract until every part of the site had ... of obstructions and the entire location of the ... delivered over to the plaintiff for the perform... work. In our opinion there was an implied ... on the part of the defendant to furnish to the ... within 15 days from the date of the contract, the entire site of the dam cleared of obstructions upon which to build the dam in question, without interference on the part of the defendant.

We are of the opinion further that the delay of the defendant in locating or delivering to the plaintiff the site cleared of all obstruction, for the erection of the dam, and the fact that defendant permitted the plaintiff to proceed with the work after the time fixed for its completion and accepted the work, tends to show that the time limit was either waived altogether, thus giving the plaintiff a reasonable time to complete the contract, or, that defendant extended the contract time to completion by a period equal to the delay caused by the defendant either in failing to deliver the site or in obstructing the work of the plaintiff after the work had been commenced, and that the defendant thereby waived any and all right to the liquidated damages provided for in the contract for delay on the part of the plaintiff.*

We think it is a necessary inference from the terms of the agreement that the Sanitary District of Chicago undertook to provide the site for the dam in question properly excavated in its channel; and that the failure of the Sanitary District to deliver over the entire site of the dam to the plaintiff for the prosecution of its work under the contract for the length of time as shown by the evidence, resulted in the delay in completing the contract by the plaintiff, and that thereby the provision in the contract for liquidated damages of $100 per day was as effectually eliminated from the contract as if the parties had cancelled it by express agreement.

We do not think that a construction should be given to the contract between the parties to this action which would enable the Sanitary District to retard the prosecution of the work by the plaintiff, or prevent it from employing all the agencies which, in its judgment, could wisely and advantageously be used in the performance of the work called for by the contract, from the date of which the plaintiff was, by the terms of the contract, compelled to commence work, to a much later date, and, nevertheless, enforce the clause providing for $100 liquidated damages per day for every day after the date fixed by the contract for the completion of the work. The plainest principles of justice would forbid such a construction of the contract. It is unreasonable to suppose that the parties intended that the contract should be interpreted in that manner, and that it should be left optional with the Sanitary District to retard the work contemplated by the contract, at its pleasure, discretion or convenience, accept the work, and at the same time enforce the heavy penalty for the non-performance by the plaintiff.

*Now Consulting Engineer to the Sanitary District.—Ed.

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A MUCH USED CONCRETE FORM.—In the upper locks at Miraflores, on the Panama Canal, awaiting its turn for further service, lies a wooden form that has been used 20 times in making a joint between the main culverts in the side walls and the lateral culverts at Pedro Miguel Locks. It is one of the "lily forms" so called because of their resemblance to a lily, due to the fact that they represent the joint between a circular culvert and an elliptical one. It is rather a complicated pattern in appearance, and is put together in sections, so that when concrete has set around it, the form may be removed and then assembled again for further use. It cost $250, so that the cost of forms for each joint so far isa bout $12.50. This is typical of the repeated use to which the forms are put in concrete work, both in the Pacific locks and at Gatun, and typical also of the general methods that have resulted in the steady lowering of the price of concrete construction.—"Canal Record."

*Some of the contracts of the Department of Public Works, Chicago, provide that when delay is caused to the city, the contract time shall be extended for a period equal to the delay.—Ed.

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In this issue we have taken advantage of a coincidence which brought to us about the same time from widely different sources two articles on the irrigation works in that arid triangle lying close up under the Himalayas at the north end of the Indian peninsula, a subject rather remote from the ordinary practice of the American engineer. That very remoteness, which makes the accounts novel to most of our readers, together with the interesting nature of the works described led to our acceptance and publication of the articles.

The continent of Asia, particulary India, is the birthplace of irrigation engineering. There, while this new world was still in the hands of the savage, the necessities of life led men to bring from the mountain-fed rivers the water which the deficient rainfall could not supply. The problem has always been more the requirements of a sufficient food supply rather than the financially profitable reclamation of hitherto useless land, though in the later developments this economic possibility has, of course, entered. On account of the kinds of labor available and the political and social conditions in the country the constructions have not progressed far beyond the elemental types, but these conditions have in no way interfered with the magnitude of the projects nor with the degree of efficiency to which the elemental types of construction have been developed. However, with all the great area now under irrigation, there has not as yet been a necessity or possibly an opportunity for any but river diversions, though the time is bound to come when the question of storage must be met.

To those familiar only with the irrigation projects in our arid west, where an irrigated area of 300,000 acres is a rare maximum and where the flow is led through canals seldom exceeding 20 miles in length or 1,500 sec.-ft. in capacity, the size of the Punjab projects is enormous. Irrigated areas running above a million acres and canals equaling the flow of a fair size river are the rule rather than the exception, as the figures given by both Mr. Sejur and Mr. Bligh show, and the list is annually being added to by other projects equally as large. As an example of the directly beneficent effects of the art and practice of engineering on a lower grade civilization this great work in the Punjab is pre-eminent.

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It is one of the foundation principles of our government that every individual has a right to "life, liberty and the pursuit of happiness." More than a quarter of a century ago it became evident that the right of the individual "to liberty and to the pursuit of happiness" might be destroyed through the operation of forces created by changes in industrial and economic conditions.

At the present day, everyone is dependent for practically all the necessaries of life as well as its comforts upon a multitude of others scattered all over the country and, indeed, all over the civilized world. The individual can secure these necessaries of life at a fair price so long as free competition is maintained. With that abridged or destroyed, however, it becomes possible to raise the price of a thousand and one articles necessary in daily living, and by this process of monopoly the liberty of the individual may be practically destroyed.

It was actual experience with these conditions, resulting in ruin and disaster to thousands and thousands of business men and increased cost of living in millions of homes that led to the enactment of the Anti-Trust Laws of 20 years ago. For the first time the power and significance of the federal law against Trusts has been decided by our highest tribunal, the Supreme Court of the United States.

On May 15, that court rendered its decision in the case brought for the dissolution of the Standard Oil Co. of New Jersey on the ground of its maintenance of a monopoly. The court holds in clear terms that the act of Congress forbidding the attempt to monopolize any part of interstate commerce is constitutional; that such monopolies may be broken up by process of law, and that those who form them may be punished by fine and imprisonment.

The chief argument of those who attempted to defend the Standard Oil Co. and similar monopolies has been that their organization is an evolution of modern industrial development, and that without forfeiting all of the advantages to be gained from concentration of capital and organigation of industry on a large scale, such combinations cannot in any way be restrained and forbidden. The claim is, in other words, that combination to gain business economies is so closely interwoven with combination to restrain competition that one cannot be forbidden without forbidding the other.

Taking a broad view of the Supreme Court's decision, this latter view appears to be plainly denied. The court declares that the statute must be interpreted in the light of reason and common sense. The court will not annul and punish agreements between different pipe line companies, for example, the object and nature of which are to afford continuous carriage of petroleum from the oil fields to the refineries. It will not annul other contracts which have for their evident object harmonious and economic cooperation between different parts of a great productive organization. It will, however, apply the law in each and every case where the intent and effect of the combination can be shown to be the limitation of competition.

It may well be believed that the courts will view with different eyes contracts which have been entered into hitherto, before the Supreme Court had announced its interpretation of the Sherman law, and contracts which may hereafter be made. Any person or concern who shall hereafter undertake to in any way combine competing firms or companies doing an interstate business, with the evident intent of creating a monopoly and controlling prices, will put himself in peril of fine and imprisonment. On the other hand, combinations which have for their evident object the efficient organization of industry, the substitution of economic operations on a large scale for wasteful operations in small plants and the better and more economic distribution of product, need have no fear of the law.

Undoubtedly, combinations hereafter formed will be judged largely by their results. If the organizers of future combinations seek immunity on the ground of innocent intention, they will do well to prove it by bestowing actual benefits upon the public in reduced prices and excellent products rather than attempting to extract additional profits through their power over competitors.

And a very similar rule applies to the hundreds of combinations already in existence, which, indeed, permeate almost every branch of commerce and trade. Firms and corporations which seek to maintain arbitrary prices, which can be shown to be operating substantially without competition and to be using any effort whatever to suppress, by what are generally recognized to be unfair and dishonorable methods, the entry of new competitors into the business—these may well expect to suffer the penalties of the law. This, it seems to us, is a fair conclusion from the ruling which the Supreme Court has just made.

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The time penalty clause in engineering contracts is a frequent source of dispute and litigation, and a court decision which is recorded elsewhere in this issue lays down some important principles as to the rights of the contractor. Briefly, the contractor in this case was required to commence work within a specified time and to complete it by a specified date. By implication, the owner was under obligation to have the site ready for the contractor by the date he was to begin work; but this was not done and the contractor was hindered in the carrying out of the work by causes beyond his control so that he could not complete it by the date specified. The opinion of the engineering and legal advisers of the public authorities for whom the work was done, was to the effect that under the conditions the penalty should not be imposed and probably could not be collected.

The authorities, however, insisted in holding the contractor responsible, partly (it is stated) on account of the moral effect upon other contractors, and the matter was taken into court. The court (whose decision is quoted elsewhere) holds that the delay of the authorities in making the site available for the use of the contractor effectually eliminated the penalty provision of the contract. Further, the court holds that "the plainest principles of justice" would forbid a construction of the contract by which the authorities could retard the prosecution of the work after the date on which the contractor was required to commence it, and still be allowed to enforce against the contractor the penalty for delay in the completion of his work.

This decision accords well with reason and common-sense. The time requirement in a contract is often a matter of the greatest importance; and when a contract is let, the date of beginning work is naturally set at the earliest date possible. If it is impossible to furnish the contractor necessary facilities on that date, the fair way is to insert in the contract such a clause as is in use by the City of Chicago on some of its work, as follows:

"If the contractor is delayed by the city, the time of delivery will be extended for a period equal to that of the delay."

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When an engineer has to take charge of the street cleaning department of a city and seeks to introduce efficient methods of management, one of the first difficulties he meets is in finding how much work a street sweeper should be expected to do in a day and how much expense the city ought to incur per thousand square yards of pavement cleaned.

It is generally agreed by American travelers abroad that the streets of Berlin are kept cleaner than those of any other great city of the world. The methods in use and the results obtained there are, therefore, of particular interest to engineers.

In this issue of Engineering News Mr. Rudolph

Hering describes the street cleaning organization of Berlin and gives the results obtained there reduced to American units of weight, measure and money, so that results obtained in American cities may be readily compared.

Of course, it must be kept in mind that with Berlin's smooth pavements and well organized force of municipal workmen, far greater efficiency in street cleaning work is to be expected than any American city can hope to attain. Nevertheless, the Berlin results are worth study, since they show what results can be actually attained under the most favorable conditions. They may encourage the keeping of street cleaning accounts and records in American cities on some uniform basis reducible to the same units, so that results obtained in one city would be comparable with those obtained in another.

The arbitrary establishment of incompetent men as engineers by process of law is the proposition embodied in two bills introduced in the Illinois legislature. These bills were prepared ostensibly to improve the existing laws relating to the office of county surveyor. In the first place, the bill made no provision for securing men who are competent to perform the duties of the office of surveyor. In the second place, it made the incumbent also "county engineer" and provided a loophole by which he might still hold this office even if he were not competent to discharge its duties. The bill was proposed and backed by an association of county engineers. As originally introduced, it contained the following clause:

> The county surveyor * * * shall be engineer in charge of all construction or surveys within his county required by the county or the township officials, or by order of any court, or by application of any person thereof: Provided, further, that nothing in this act shall be construed to constrain the county or township officials to place the county surveyor in charge of any engineering work if he is incompetent to take charge of such work; and provided, further, that nothing in this act shall be construed to prevent county or township officials from placing road and bridge work under the charge of the State Highway Commission.

It will be noted that nothing is said as to how or by whom the surveyor's competency as an engineer is to be decided in case of dispute. Evidently a self-confident man might assume charge of work for which he had no qualifications.

Since the county surveyor may be incompetent even as a surveyor, the folly of making him an engineer by virtue of his office is apparent.

The bill was amended in the legislature by striking out all reference to engineering work. But even then the incompetent county surveyor was provided for by a statement that the county surveyor should be in charge of all surveys but that the county or township officials need not place him in charge of any work, "if he is incompetent to take charge of such work." Later, however, another bill was introduced which restored the provisions of the original bill in regard to engineering work.

Another bill before the Illinois legislature makes the county surveyor the "superintendent of roads and highways" in the county, with nothing said as to any requirement of competency. As an offset to this, a bill was introduced creating the additional office of county superintendent of roads. Originally this bill required that the incumbent should have at least three years practical experience as a civil engineer, and that preference should be given to graduates of colleges of civil engineering. It was amended to provide simply that he should be "a competent surveyor and civil engineer." In view of the vagaries of legislative action it is impossible to predict what shape the bills will be in when finally passed (if, indeed, any of them are passed).

The unfortunate fact is that the office of county surveyor in many states of the West has become a political position and men are elected or appointed to it who are wholly incompetent to discharge its duties. The public little appreciates the loss and damage which it suffers through inaccurate and reliable surveys; and the lawyers who benefit from the litigation which grows out of such surveys have no motive to use their influence for the amendment of the law so that county surveyors should be competent to perform their duties.

In a paper presented at the recent annual meeting of the Illinois Society of Engineers and Surveyors (which society is not supporting what has been called the "bill for incompetent engineers") a county surveyor of 20 years standing in Illinois (where the office is elective) made the following statement:

> The candidate for county sufveyor may be anybody, whether qualified or not, and I believe there have been as many unqualified persons as otherwise in the office.

Certainly the law relating to county surveyors ought to be changed, but it should be changed to require competency in the men who hold the office and not to compel surveying and engineering work to be placed in the hands of men not fitted to perform it properly.

However praiseworthy the oft-announced policy of Gov. Dix of New York to conserve for the benefit of the State all the water power within its boundaries, his first practical application of the policy in the case of the Troy lock and dam at the head of steamboat navigation on the Hudson River reflects seriously on its sincerity. The facts in the case were stated in our last week's issue, p. 583, but since then certain other phases of the matter have come to our notice.

Briefly, the situation is as follows: In 1910 Congress authorized an expenditure of over $5,000,000 for the regulation of the Hudson River above Hudson, N. Y., about $1,000,000 of which was to be devoted to the construction of a dam and lock at Troy and the remainder to the creation of a 12-ft. channel in the Hudson to provide an exit for the traffic of the New York State Barge Canal, now building. This appropriation was made *against the recommendations of the Chief of Engineers* and only at the repeated solicitations of the State of New York. It was made, furthermore, only after the then Canal Board and Governor Hughes, then in office, had signed an agreement to relinquish to the United States all the water power rights at Troy. This requirement was made by the United States, not on account of any profit it expected from utilization or sale of this power, but to relieve it of any possible difficulties with the present water-right lessees. The present power developed at Troy is about 2,000 HP. and is held under an old lease, by the Troy Hydraulic Co. It is estimated, however, that by the construction of a new dam the power may be increased to some 6,000 HP.

Under this appropriation, work has been started on the river, though not yet on the dam. Now comes Gov. Dix and his Canal Board with an order rescinding the contract made by their predecessors, under which the appropriation has been made and work started on the grounds that this previous agreement was illegal. The reason assigned for wishing to rescind the contract is that it is impolitic for the State to relinquish control of any of the water power within its borders. This order is now before the Secretary of War for further action.

Unfortunately for the Governor and his board, the reasons they give for their action are as tenuous as those upon which they base its legality. As to the fear of a federal usurpation of control over State water powers, the government, through its engineer officers, has expressly stated that it is perfectly willing to assign to the State any power that becomes available after the completion of the dam, reserving only enough for operating purposes, and neither the previous policy of the government nor the amount of power to be developed at this place would warrant any doubt of this willingness.

Leaving aside the question of the power of one State administration to annul a contract entered into by another or questions as to whether the nation or the state has primary jurisdiction over water power in a navigable stream, the reasons advanced by Attorney-General Carmody for the rescinding of the previous order of the Canal Board are, to say the least, unconvincing.

Searching for the thought which his wishes fathered, he could only find one [illegible] for the reversal of his predecessors' action; [illegible] reported to the Governor that the State cannot [illegible] revoke the rights given to the Troy Hydraulic [illegible] because those rights were given *in perpetuity*.

Consider this legal opinion and the [illegible] read the lease made by the State to the compa[illegible] in 1872

> The lease is for the use of one-half of * * * the surplus waters created by the erection of the Sta[illegible] dam in the Hudson River * * * for the term of 999 [illegible] are * * * The lessees are to pay to the State the s[illegible] of $300 a year.
>
> [The conditions of the lease stipulate th[illegible] the lessees may have]
>
> * * * the use of the surplus water to be [illegible]ken at the east end of the dam, and not exceeding o[illegible] half of the quantity which may be taken at both ends [illegible]h surplus water to be taken and drawn * * * in su[illegible] manner as the Canal Commissioners * * * shall dire[illegible]aving and reserving to [the State of New York] th[illegible]t wholly to resume the waters hereby conveyed and [illegible] privileges hereby granted, and to control and limit t[illegible]se of said water and privileges whenever in the opinio[illegible] the Canal Board or the Legislature the necessary su[illegible] of water for use of any state canal, or the safety [illegible]h canal, or works connected therewith, shall render [illegible] resumption, control or limitation necessary. An[illegible] case any such resumption shall be made, or control [illegible] limitation imposed, no compensation or damages sha[illegible] allowed for any improvements or erections made [illegible] * * * And also saving and reserving to [the State of N[illegible] York] the right, without making any compensation to [illegible]e lessees] * * * wholly to abandon or destroy the [illegible] by the construction of which the said surplus wa[illegible] has been created, whenever, in the opinion of the Ca[illegible] Commissioners, the occupation and use of said work[illegible] all cease to be advantageous to the State.

If this be a lease in perpetuity, the lay mind is in sad confusion. And does it seem to the honorable gentlemen that a payment of $300 a year in perpetuity for power worth $600,000 per annum is *conservation* for the benefit of the State?

Aside from the question of power rights, the success of Governor Dix's claim would mean the present cessation of all work under the $5,000,000 appropriation of Congress, because the grant of that money was conditioned on the relinquishment of the water rights, and the certain expenditure of the State at some future time of over $1,000,000 for the dam and lock with a possible greater expenditure for the further regulation of the river as a canal terminal; and finally and most important, the putting off of the opening of the Champlain branch of the Barge Canal for at least two years. If the work now being started by the federal government were prosecuted with the greatest possible rapidity, it would hardly be ready as soon as the new Champlain Canal—and with the delays certain to result if the government is forced out of the project, boats will be coming down from Lake Champlain a full two years before they can get into the Hudson below Troy and fulfill the expected destiny of the Barge Canal.

## The Peril of a Water Famine in New York City: What Can Be Done to Avert It?

The City of New York is to-day in grave peril of a water famine.

What does this mean? How much does it signify to the average resident, the average workingman, the average business man in the great city? In answer to these questions we declare emphatically that this danger which menaces the city is the most important matter by far which the city now faces. It is more important than new rapid transit lines. It is more important than the freight terminal question. It is vastly more important than the crime wave, or the location of a court house, or than any and all combined of the questions which now appeal for public attention.

Why is it so important? Because a water famine—the exhaustion of the water supply on which the city is daily and hourly dependent for its life and its industry and its safety from destruction by conflagration—would be a calamity well-nigh past imagination.

New York City is dependent for its water supply upon the streams flowing from the Croton drainage area. Huge reservoirs have been built on these streams which store the flow of the streams during times of heavy rainfall for use during periods when the stream flow is low. A water famine in New York City will come when

the wat[illegible] these reservoirs is all drained away d[illegible] a period of drought, and the city is left dep[illegible]t on such water only as the natural flow of [illegible]streams can furnish.

At su[illegible]me the water-supply flowing down the Cro[illegible]queduct to the city from the dry weather [illegible]of the Croton River would not be more th[illegible]eighth or a tenth of what the great city requir[illegible]or its average daily consumption. Such a [illegible]re of the city's water supply would compel t[illegible]utting down of factories and the practical [illegible]hilation of industry in the city which has [illegible]largest volume of manufactures of any city [illegible]country. It would mean scarcity of water [illegible]domestic use in hundreds of thousands of [illegible]seholds. It would mean peril to health in[illegible]se households. It might easily bring wh[illegible]le riot in its wake.

Most se[illegible]s of all, such a water famine would place the [illegible]eat metropolis in imminent danger of destruc[illegible]n by conflagration. A few crowded sections o[illegible]he city, it is true, are protected from fire by t[illegible] high-pressure water-supply system, which can[illegible]n an emergency obtain a supply of salt water [illegible]om the adjacent rivers; but the area so protected is very small compared with the area of the greater city, where hundreds upon hundreds of millions of dollars worth of property are at stake.

It can hardly be doubted that as soon as the water famine was close at hand, fire insurance companies would cancel their policies covering property all over the city. Justice to their policy holders elsewhere would require them to do this. With the experience of Baltimore and San Francisco and other minor conflagrations fresh in our memory, no one can think of a water famine in New York without realizing the gravity of the situation.

But it may be said that by heroic measures to cut down waste the city could worry along through such a famine without serious loss. To any one who holds such a view we suggest examination of the report made by Mr. John R. Freeman eleven years ago to Hon. Bird S. Coler, then Comptroller of New York City. Forecasting the events of a water famine, which threatened New York City even at that time, Mr. Freeman said:

> With the city normally using, say, 275 million gallons per day, it could, by choking off the gates on the distribution system so water would not rise above the first stories, and by vigorous efforts to stop waste, probably cut off 50 million gallons per day, very much as was done in the early part of 1891.
>
> But to empty the reservoirs entirely, and thus have to drop to the natural drought flow, plus the little water draining out of the reservoir margins, WOULD LEAVE AVAILABLE PROBABLY SCARCELY 50 MILLION GALLONS PER DAY. This would at once shut down every factory and every steam and electric power plant in New York City, and cause an appalling amount of danger and suffering.
>
> The storage reservoirs existing in 1891 were entirely exhausted about Nov. 15. The distribution reservoirs were but partly drawn off. Fortunately, rains came promptly. Had these rains in that year been delayed one or two months, as is not infrequent, *the disaster would have been frightful and beyond remedy.*

No engineer has more thoroughly studied the water waste question in New York City, and none is better qualified to express an opinion. Mr. Freeman, 11 years ago, strongly urged the inauguration of every possible means of waste prevention including the wholesale installation of water meters; but he summed up the result of his researches on waste prevention with these words of warning:

> *It is dangerous to be hopeful about preventing waste, for with these hopes unfulfilled and RESERVOIRS EMPTIED, disaster would be beyond remedy.*

At the time, Mr. Freeman estimated that by 1910 the daily per capita consumption of New York, with waste continuing as in 1900, would rise to 155 gallons. "With the greatest effort to restrict waste that public sentiment will probably demand or support," Mr. Freeman thought the consumption by 1910 might be reduced to 130 gallons per capita.

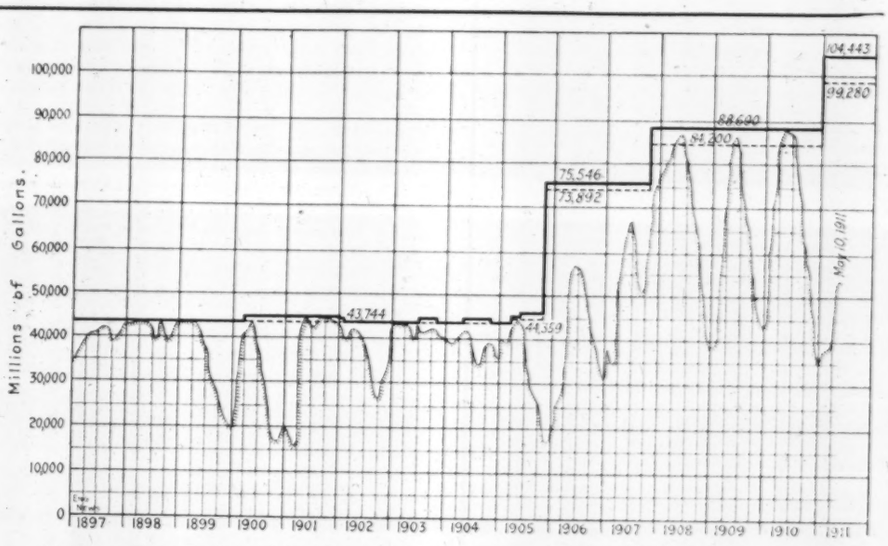
The city officials have actually done far more in cutting down waste and reducing the per capita consumption than appeared to be possible ten years ago. While the population has gone on increasing at a steady rate, the consumption of Croton water has remained practically stationary for the past four years. Under the whip and spur of necessity, waste has been cut down and the daily per capita consumption reduced to about 117 gallons a year ago, and for the first ten days of the present month to somewhat less than 107 gallons per capita.

Previous to 1907 the daily consumption of Croton water in New York City steadily increased by about 12,000,000 gallons per annum. Had systematic waste prevention not cut down the consumption, the city would, to-day, be using some 375 million gallons daily—that is, if it had that much to use, for with any such rate of consumption of water the city would to-day be close to the end of its resources. In other words, only the radical waste prevention measures, which have been adopted have prevented a water famine from reaching us already.

But it may be asked, why is the danger at the present time more serious than it has been in the past. For more than a dozen years, engineers have been talking of the danger of a water famine in New York; and the famine has not come. Why is there need for particular anxiety at present?

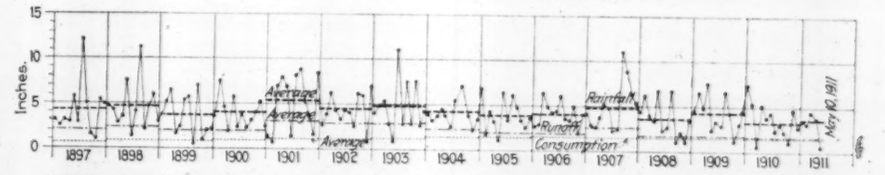
Let us see if we can make clear to the dullest comprehension why the present situation is so serious as to demand immediate and radical action.

It is true that engineers who have studied the New York water supply situation have been gravely anxious for more than a dozen years. In

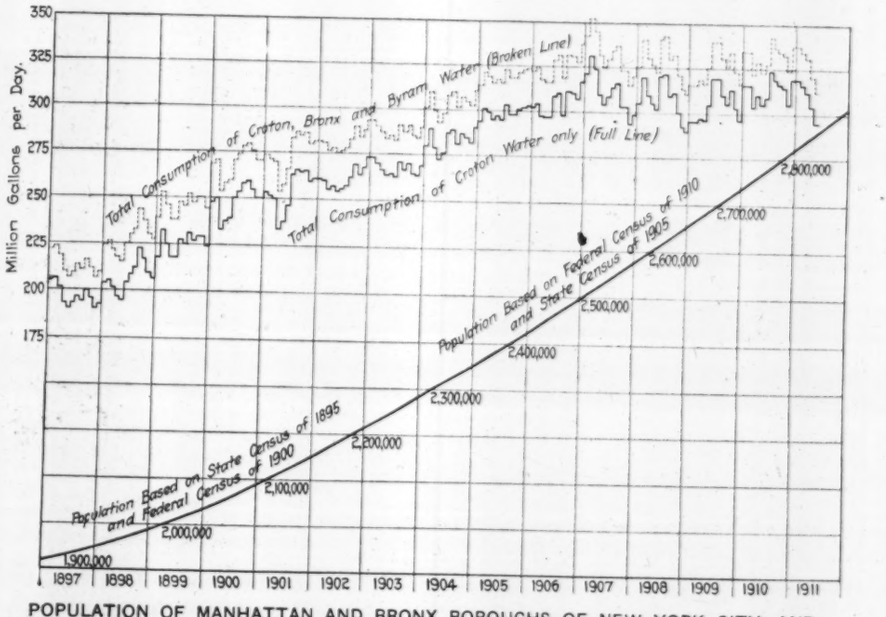



TOTAL AMOUNT OF WATER STORED IN CROTON RESERVOIRS, 1897 TO MAY 10, 1911.

(Horizontal lines above curve show total available capacity of reservoirs; the dotted line without flashboards on the dam-crests, the full line with the flashboards.)




MONTHLY RAINFALL IN INCHES ON CROTON WATERSHED AND AVERAGE FOR EACH YEAR OF MONTHLY RAINFALL, RUNOFF, AND CONSUMPTION OF CROTON WATER, 1897-1911.




POPULATION OF MANHATTAN AND BRONX BOROUGHS OF NEW YORK CITY, AND CONSUMPTION OF WATER FROM CROTON, BRONX AND BYRAM WATERSHEDS, 1897-1911.

1900 New York City consumed about 240 million gallons of Croton water per day and the consumption had been growing for several years with an average increase each year of some 12 million gallons per day. Mr. Freeman, in his report of 1900, declared that the safe yield of the Croton watershed was not above 275 million gallons per day and showed that by 1905, the probable increase in consumption of water would carry the city past the line of safety. We quote from his report as follows:

SAFE LIMIT OF CROTON WATERSHED, 275 MILLION GALLONS PER DAY.

I therefore strongly recommend that 275 million gallons per day be regarded as the greatest allowable annual average draft from the new Croton Lake of 1902 under the best possible utilization of the storage, and with the possibility that once or twice in a century a succession of years of low rainfall may so curtail the supply *that the average outflow for a 4-year period would be only 260 million gallons per day.*

In other words, Mr. Freeman clearly recognized at that time that two or three exceptionally dry years coming together, such as had actually occurred in the past, might produce a water famine in New York City, even with the consumption of water which existed then.

What has happened since that time? In the first place additional reservoirs have been built in the Croton watershed raising the total storage from the 85 billion gallons, assumed by Mr. Freeman in his computations eleven years ago, to 104½ billion gallons. In the second place, the consumption has gone on increasing, until it has reached an average of about 315 million gallons per capita for the last four years. In the third place the yield of water from the Croton watershed has been deficient for the past three years, as the accompanying diagram clearly shows.

The dangerous situation of New York City, which Mr. Freeman set forth ten years ago, was masked from the public, and even from many engineers, by the heavy rainfall and large run-off from the Croton water shed which continued from 1900 to about 1905. The average yield of the Croton watershed during these years was very much higher than the average yield which it had afforded during the 40 years since New York first drew its supply from that source. In the summer and fall of 1905, however, came a long period of severe drought. In November, 1905, the stored water in the Croton watershed had been drawn upon until only 60 days' supply was left in the reservoirs. The winter rains following replenished the reservoirs, but there was dry weather again in the summer and fall of 1906 In December, 1906, the storage had been drawn upon until only 100 days' supply was left in the reservoirs. The year 1907 was phenomenally wet. The rainfall in the Croton watershed was 57.30 ins.—nearly 10 ins. more than in the previous year, and there was an opportunity, therefore to fill the reservoirs to their maximum capacity.

Since 1907 every summer and fall have been periods of severe drought. Every year the Croton reservoirs have been drawn upon for a volume of water greater than they have ever been called on to furnish before, and only the great increase in storage capacity furnished by the reservoirs completed in the last dozen years has enabled the city to escape famine. Every year, however, the winter and spring rains have been sufficient to restore the depletion and furnish a supply for the next drought period.

The peril of the present situation lies in this; that the rainfall during the winter and spring of 1910-11 has not been sufficient, as in every one of the previous five years, to refill the depleted reservoirs. The amount of water in the reservoirs at the present time is only 54 billion gallons. While in previous years the city has started in upon the dry months of summer and fall with a large amount of water stored in the reservoirs, we are this year starting in on the same period with the reservoirs already depleted. If another such summer and fall as that of 1908 and 1909 and 1910 is in store for us, New York may use up all of its available supply of stored water before the end of the present year.

It may be said, however, why is the peril more serious in New York than in other cities? Other towns and cities have had to face water famines and have found some way to bridge over the danger and difficulty. Why is the situation so much more serious in New York?

There are two reasons for this. The first is the hazard of conflagration and the hazard to health in a city so densely built up and so densely populated. The second is the grave difficulty which New York finds in obtaining any emergency supply.

Although the old City of New York, situated on Manhattan Island, is surrounded by water, it might as well be situated in an arid desert so far as a supply of water for ordinary use is concerned. The Hudson River on one side and the water of the East River, an arm of Long Island Sound, on the other, are practically as salt as the ocean itself, and are too grossly polluted by sewage in addition to make their use feasible in the city water mains even as an emergency supply.

To the west lies the Hudson River, with the State of New Jersey on the opposite side. The depth and the width of that stream are too great to permit a pipe line to be carried across by either bridge or tunnel in the time necessary for emergency use, even would the State of New Jersey permit potable water to be carried outside of its borders.

The Hudson River itself is likely at any time to be brackish from admixture of salt water nearly as far as Poughkeepsie, so that that stream is unavailable for emergency use.

For an emergency supply of potable water, therefore, New York must go to areas north of the Croton watershed. Between the Croton River and New York City there are no streams whatever of any size that are not already drawn upon to their full capacity.

In the area north of the Croton, between the Hudson and the Connecticut State boundary, the two principal streams are Fishkill Creek, flowing into the Hudson, and Ten Mile River, flowing across the boundary into Connecticut and there emptying into the Housatonic.

The former stream is comparatively small and the divide between its waters and the Croton, which an emergency pipe line would have to cross, is nearly a thousand feet high. Ten Mile River, on the other hand, can easily be made tributary to the Croton supply. It was strongly recommended by Mr. Freeman ten years ago as the source of additional supply for New York most immediately available. Had his recommendations been appreciated at their full importance, and the gravity of his warnings been understood, Ten Mile River would have been drawn upon by New York City years ago, for at least a temporary supply, and the risk which the city has run all these years and the present grave danger would have been averted.

The Ten Mile River drains an upland area of 200 sq. miles, nearly five-eighths as large as the Croton's watershed. Mr. Freeman proposed a dam

MAP SHOWING PROPOSED LOCATION OF PUMPING STATION AND PIPE LINE FOR DELIVERY OF WATER FROM TEN MILE RIVER INTO CROTON DRAINAGE AREA.

(Reproduced from Clove Sheet, U. S. Geological Survey.)

about 130 ft. in height, which would raise the water to an elevation high enough for it to flow by gravity across the divide into the Croton watershed. He estimated that with the storage thus afforded at least 150 million gallons daily could be added to the Croton supply.

Of course for an emergency supply there is no time to build a storage dam. What would have to be done would be to take the natural flow of the river. It is probable that during at least ten months of the average year the Ten Mile River could be relied upon for a flow of 50 million gallons per day. A pipe line, about 7½ miles long, would deliver the water from the pumping sta-

tion across the divide into the Croton watershed, with a total lift of less than 100 ft. The quality of this water is equal to that of the Croton itself, and if there were any doubt concerning its freedom from pollution, it could be easily treated with hypochlorite to render its use for domestic purposes perfectly safe.

We hardly need say that so far as the work of engineering construction is concerned, there would be no difficulty in building pumping station, pipe line and all appurtenances and rushing the work at the highest possible speed. By using standard boilers and pumping engines, quickly obtainable, and dividing the pipe-line among a number of contractors, it ought to be possible to complete the entire work in two to four months, *provided* the city realizes the danger which confronts it sufficiently to pay for and to insist upon the highest rate of speed in construction.

Will it may be said, would 50 million gallons a day be sufficient to avert the danger of water famine, when New York's present consumption is nearly seven times that amount? The answer to this is that if famine actually comes—if the months ahead of us are to be months of drought like those of recent years—then the flow from the Ten Mile River to supplement the low water flow from the Croton will be the most precious and valuable water that has ever crossed New York's northern boundary. It will save life and property as has no other public water supply ever introduced in the United States.

Suppose, however, we are again lucky and months of heavy rainfall again replenish the depleted Croton reservoirs before they go dry. Then New York will again be free from danger. The safe yield of the Croton, which was set by Mr. Freeman at 275 million gallons, in 1900, with 50 million gallons additional from the Ten Mile, will bring the available supply that can be safely relied upon nearly up to the present rate of consumption.

It is true that to make New York wholly safe, we ought not to stop at the Ten Mile River supply. The right ought to be obtained from the Connecticut legislature, now in session, to go across the state line and set up pumping plants on the Housatonic itself for use whenever the conditions of emergency in New York shall demand.

But it will be argued that the end of New York's peril is almost in sight. That two years hence *it is hoped* the Catskill aqueduct may be sufficiently far advanced to be put into use from the Ashokan dam as far south as the Croton reservoir, so that abundant water from the Esopus will be brought to the relief of the imperiled city.

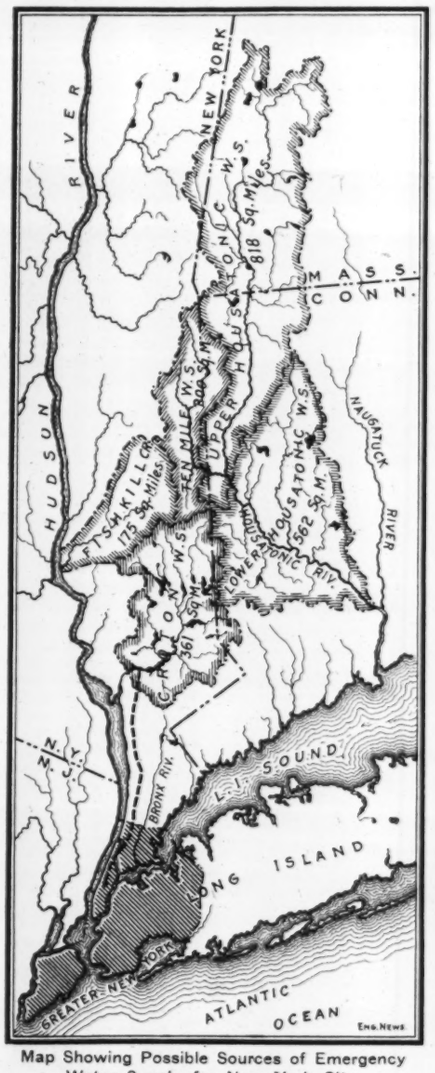
Even so, we believe the risk of water famine during the coming two years is so serious that no effort and no expense should be spared to avert it. The loss from a single day of water famine in New York City would be far greater than the entire cost of the temporary supply from Ten Mile River, which we have here proposed.

We say *it is hoped* to bring Catskill water down as far as the Croton reservoir in two years. But there are possibilities that a much longer time may elapse.

An essential part of this long conduit from the Catskills is the tunnel which is yet to be driven at great depth beneath the Hudson River at Storm King. We have no desire to exaggerate the uncertainties in connection with this tunnel. It is, of course, believed that it will be possible to drive it, notwithstanding such water-bearing strata as may be encountered deep down underneath the gorge through which the Hudson flows. It is not at all improbable, however, that difficulties may be encountered in the progress of the tunnel which will cause delay. The strata through which it is driven and the difficulties with drainage may prevent pushing the work at any great speed. It is quite within the possibilities, therefore, that, instead of its being two years or three years, before the Catskill water can avert the peril which threatens New York City, it may be four or even five years.

Under these circumstances it seems to us that not a moment should be lost in putting an emergency plant in operation to add the flow of the Ten Mile River to that of the Croton for the supply of New York City.

Just imagine that at a distance of only seven or eight miles from the Central Park Reservoir, there was flowing a pure mountain stream, draining an area of some 200 square miles. Under such circumstances, no one can doubt that at least ten years ago this water would have been added to New York's present supply. Actually, so far as any engineering difficulties are concerned, *the Ten Mile River is as near to Central Park Reservoir as if it flowed into the Hudson at Spuyten Duyvil.* An inexpensive and quickly erected pumping plant




Map Showing Possible Sources of Emergency Water Supply for New York City.

and pipe line will bring its flow to a point from which it will flow by gravity all the way to New York.

What, then, are the difficulties in the way? As is usually the case, the legal obstacle is the one brought forward as insuperable. The Ten Mile River flows into the State of Connecticut, where it empties into the Housatonic River, just below the point where Mr. Freeman proposed to erect a dam as above mentioned. The mill owners on the Housatonic would, of course, be entitled to damages for the injury to their water power during the time while New York should divert the flow of the Ten Mile River for its own consumption.

These mill owners could, of course, appeal to the Federal Courts for injunction to prevent New York proceeding with works to divert the river. On the other hand, with good business management it should be possible to forestall such litigation and arrange by private agreement with the parties affected. If such offers were made, it seems very doubtful whether the federal courts would interfere by injunction with the carrying out of the work so vitally necessary to save the greatest city of the New World from serious peril. If the city gave bonds to recompense the mill owners for their damages in reasonable amounts, to be determined by the courts, no injunction should be issued.

Another legal obstacle in the way is a statute of New York state enacted seven or eight years ago, absolutely forbidding New York City to take water for its needs from Dutchess County through which Ten Mile River runs. Immediate appeal should be made to the New York legislature, now on the eve of adjournment, to repeal this law and grant New York City any needed powers to secure this emergency supply.

Is there anything unreasonable in appealing to the Legislature for such relief? Suppose the City of New York were threatened by a general riot, or that in case of war, it were threatened by an enemy. Under such a situation the ordinary processes of law, with all their delay and circumlocution, would be swept aside; martial law would be declared; anything and everything necessary to secure the safety of property and life in the city would be done. It is a fact, however, that a water famine in New York might cause greater destruction to life and property than either the siege of an enemy in wartime or riotous anarchy in its streets.

The legislatures of New York and of Connecticut should be as ready to save New York from danger of water famine as they would be to order supplies to aid her defense if an enemy were besieging her in wartime.

It is the business of the engineering profession to get things done. It ought to be equally the business of the legal profession to secure the ends of justice without unnecessary delay and expense. The proposition that New York City must be exposed to the danger of water famine because of legal difficulties in securing water which is flowing to waste just across a state boundary is a proposition calculated to bring the law into contempt.

For this is not a matter which affects New York City alone. Upon her markets and upon her industries the rest of New York State and the adjacent portions of Connecticut are largely dependent. In fact, disaster to New York City, such as may easily come to pass, will be calamity to the nation at large.

The measure we have suggested is the quickest and easiest method by which relief from impending danger can be secured; but to be effective it must be done *at once.* Not a day nor an hour should be lost. There will be delays enough at best in installing the plant and getting it into operation. If the city waits until the water famine is actually upon it, until the last gallons of water are flowing out of the reservoirs, it will be too late then—far too late to give any relief whatever from the grave peril with which New York will then be face to face.

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An advance proof of the above editorial was submitted to Mr. Rudolph Hering, of the Board of Engineers which reported in 1903 on the need of an additional water-supply for New York City, and which recommended the Catskill supply now under construction. A letter from Mr. Hering is appended.

Sir: Every one who has followed the history of water famines in general and that of New York in particular, from the time when the first aqueduct was built to the time when the second aqueduct was opened, will agree with you regarding the necessity of prompt action to avert disastrous consequences to our metropolis. Such prompt actions were taken before, to the extent of possibilities, and in some measure prevented serious troubles. So long as people in general still have water in sufficient quantities to satisfy their wants, they cannot, when approaching the limit of supply, easily be brought to realize the inevitable, which is that the curves of increasing population and limited water supply must necessarily intersect and thereafter cause a famine.

It was not difficult to predict the present condition more than a decade ago, when the Comptroller of the

city, and the Merchants' Association each took up independently the question of an increased water supply. Reports were made at that time to the Comptroller by Mr. John R. Freeman and to the Merchants' Association by Messrs Foster Crowell, Jas. H. Fuertes, Wm. B. Fuller and the late J. J. R. Croes and Geo. W. Rafter.

In these reports the prevention of water waste was strongly urged and the need of haste in the provision of a supplementary supply was emphasized.

Mr. Freeman in his report of 1900 recommended the Ten Mile and Housatonic Rivers for a future supply. The Merchants' Association, however, through its legal advisers was informed that this supply could not be legally obtained and it therefore confined its investigations to other sources. But all engineers agreed that the Housatonic was by far the best and cheapest source of water for New York City, even after paying the State of Connecticut and its inhabitants for all reasonable damages. There stood nothing in the way of its utilization but a law that prohibited the carriage of water from one state to another.

It is for the people themselves to say how long such artificial laws shall be permitted to injure public health and compel the unnecessary expenditure of enormous amounts of money. Had the Housatonic supply been selected for New York's supply ten years ago, no water famine would now be in sight.

We have arrived at a condition when the danger is so imminent that it can be plainly seen by many more than the few experts of a decade ago.

Whether the theory of law which then prevailed and is largely responsible for the present predicament can now be side-tracked in favor of Ten Mile River, so as to relieve the present situation, remains to be seen. No nearer water supply exists of sufficient magnitude, economy and quick availability to prevent a serious calamity should the deficiency of rain-fall continue until next autumn.

Rudolph Hering.

New York, May 15, 1911.

# LETTERS TO THE EDITOR.

## Steam Shovel Output and Cost Data: Cumberland-Connellsville Extension of the Western Maryland Ry.

Sir: The following data is the record made by a 70-ton steam shovel on the first division of the Cumberland-Connellsville Extension of the Western Maryland Ry. for the month of March, 1911. The shovel was working in a 134,000-cu. yd. cut near camp No. 7. A total output of 37,100 cu. yds. was accomplished in 30 working days of 10 hours each. (A profile of this portion of the line is shown in Fig. 1 and the partially completed cut in Fig. 2.)

In order to make the fill by the scheme adopted it was necessary to use a switchback with a 3.5% grade from the mouth of the cut to the point of switchback, a distance of 950 ft. The length of haul, from center of gravity of cut to center of gravity of fill, was 1,600 ft., measured on the dinkey track. Midway of the switchback was a passing siding, open at both ends, long

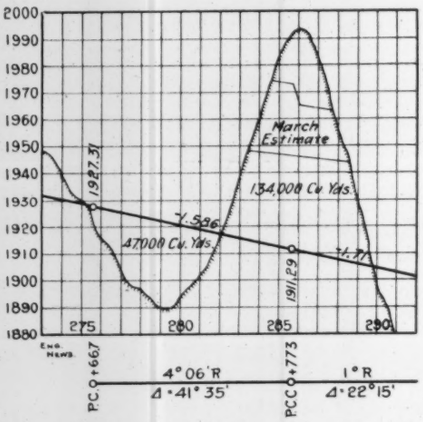



Fig. 1. Profile of a 134,000-cu. yd. Cut on the Cumberland-Connellsville Extension of the Western Maryland Ry.

enough to hold a dinkey and 12 dump-cars. This gave the empty train a clear right-of-way to the shovel as soon as the loaded train had cleared the uphill switch.

A gang of 1 foreman and 4 laborers maintained the track in such good condition that it was possible for a 16-ton dinkey to haul twelve 4-cu. yd. cars at a high speed. A dump gang of 1 foreman and 8 laborers was able to take care of the material at the fill and keep the dump in good shape.

A trestle on the uphill side of the center line was used to start the fill. To prevent the cars from overturning while being dumped, the down hill rail on the trestle was given considerable superelevation. This made it unnecessary to chain the cars to the trestle except when large boulders were handled. The fill was completed by laying the track on the dump and shifting it when necessary.

For the first 15 days of the month the material was a hard sandstone, and in blasting, this material broke into large boulders, the dumping of which required frequent chaining of the cars to the trestle. Of this material a total of 16,000 cu. yds. was moved. During the last half of the month a black shale was encountered, of which 21,100 cu. yds. were moved.

In the course of the month the shovel had to be shifted five times, each time a distance of about 500 ft. The grade left by the shovel in making each cut was always in a uniform condition for moving the shovel back for a new cut; and when the dinkey track was thrown it required little surfacing to put it into shape. There was an average loss of an hour per day in shifting the track on the dump.

The total number of car loads for the month was 12,443. The average number of car loads a day was 415; and the average load per car was 2.98 cu. yds. The largest day's work was 830 car loads.

The excellent showing made during this month was due chiefly to the ability and management of the contractor's superintendent, Mr. W. M. Douglas. The steam shovel, dinkeys, cars and all equipment were kept always in first-class condition, and the track was maintained in a manner that would have done credit to some standard gage railways. An excellent boarding camp for the laborers was an important part of the outfit and the good feeling between the superintendent and his men was always in evidence.

The equipment consisted of a 70-ton Bucyrus shovel, two 16-ton Vulcan dinkey locomotives, twenty-four 4-cu. yd. Western dump-cars, 54 tons of 60-lb rails and a Cyclone well drill. The contractors were the J. B. Carter Co., of Chicago, Ill.

| | |
|---|---|
| Total expense of the shovel including pay of superintendent, walking boss, shovel and dinkey crews and all other labor | $3,623.00 |
| Explosives | 302.00 |
| Trestle | 229.00 |
| Coal | 235.00 |
| Oil and waste | 32.00 |
| Water | 112.00 |
| Interest on plant | 110.00 |
| Depreciation | 460.00 |
| Total | $5,103.00 |
| Total yardage | 37,100.00 |
| Cost per cu. yd | .13¾ |
| Labor per cu. yd | $0.09¾ |
| Explosives per cu. yd | 0.00⅛ |
| Trestle per cu. yd | 0.00⅙ |
| Coal per cu. yd | 0.00⅛ |
| Oil and waste per cu. yd | 0.00 7/32 |
| Water per cu. yd | 0.00⅓ |
| Interest per cu. yd | 0.00⅓ |
| Depreciation per cu. yd | 0.01¼ |
| Total | $0.013¾ |

B. M. Langhead, Resident Engineer.

Frostburg, Md., April 20, 1911.

## The Abandonment of the Contract System for Public Land Surveys.

Sir: Engineers and U. S. Deputy Surveyors in the West have been watching with some interest the work of carrying on U. S. Public Land Surveys under the new system established within the past year, placing the deputy surveyors under the Civil Service. By an Act of Congress passed during the spring of 1910 the practice of having the Public Land Surveys made under contract, by any competent surveyors, who submitted the lowest bids, was done away with, and since that time no new contracts have been let.

The rectangular system of survey of the Public Lands was inaugurated in 1785 by Congress. It provided for townships six miles square, containing 36 sections each one mile square. The first surveys were made in Ohio under the direction of the Geographer of the United States, and only the exterior lines were run, mile corners being set. The plats, however, were marked by subdivisions into sections of one mile square, numbered from south to north, commencing at the northeast corner and progressing in tiers westerly, section 1 being at the northwest.

In 1796 a Surveyor-General was appointed, and [illegible] in Ohio were divided into townships which were [illegible] divided into sections by parallel lines two miles a[illegible] each way. The sections were numbered by the m[illegible] still in use, beginning with No. 1 in the northeast [illegible] tion and proceeding west and east alternately, w[illegible] progressive numbers to 36.

In the year 1800 townships were subdivided by l[illegible] one mile apart, each way, and since then developmen[illegible] the system has steadily advanced. At present [illegible] are 31 principal meridians and base lines gover[illegible] surveys over the entire portion of the United S[illegible] surveyed (or to be surveyed) under the rectangular [illegible] tem, which does not include the original 13 state[illegible]

The principal meridians were run due north [illegible]

FIG. 2. CUT ON THE CUMBERLAND-CONNELLSVILLE EXTENSION OF THE WESTERN MARYLAND RY.

south, the base lines east and west, according to the curvature of the earth. Guide meridians are projected north and south 24 miles apart and standard parallels east and west 24 miles apart, the error of closure and convergency of meridians being thus confined to tracts 24 miles square. Townships six miles square are then regularly surveyed from the standard parallel on the south and the guide meridian on the east, throwing the errors into the north and west tier of sections.

Practically from the beginning the work has been done by contract by Deputy Surveyors appointed by the Surveyor-General in each district. Since 1886, deputies have not been appointed, the awarding of a surveying contract being regarded as the appointment of a deputy, and the appointment and authority ceasing with the termination of the contract.

In former years the Government permitted the use of stones or stakes of prescribed sizes for the use of corner monuments, witnessed by accessories such as bearing trees, pits and mounds of earth or stone. As the surveyed lands were then in regions where trouble with Indians was a constant source of annoyance and danger, and as at that time western lands were thought to be practically worthless, the deputy surveyors were, more often than not, careless and negligent in their work. The Department was then rather lax in its inspection of surveys before paying for them and the net result was that thousands of miles of surveys are now found to be very erroneous and so poorly monumented that in many cases resurveys have been necessary. In these resurveys, land claims filed on under the original survey are surveyed out in their original location, while all public land is made to conform to the more accurate and better monumented resurvey.

Of late years, however, the Department has so improved its methods that very satisfactory results have been obtained. For determining meridians and the course of lines, astronomical observations are required as the magnetic needle is not of sufficient accuracy or reliability. Where the deputy uses solar observations, he must first check its indications by observations on Polaris. The result of this requirement has been the development of the Smith solar attachment, which is the most practical instrument for running these lines, as it is much more rapid than back-sighting or direct solar observations and is of sufficient accuracy, it being common practice now to do work with the error of alinement not exceeding two minutes of arc. Instead of the old cumbersome and inaccurate link chain, deputies use narrow band tapes from 500 to 1,000 links in length, and where ground is not level the vertical angle is taken with the clinometer and the horizontal measurement taken from pocket tables.

Of late years the Government has required the use of iron posts for corners. These are of three sizes: 3-in. for township boundaries, 2-in. for section corners and closing corners, and 1-in. for ¼-corners and private land claim corners. All posts are 3 ft. in length, are set 2 ft. in the ground, and are provided with brass caps on which are stamped the township, range, and

...numbers. These make very permanent and ...ory corners.

...requiring of greater accuracy in the work, the ...of iron posts, the increased difficulty in the re... due to private land claims, the pushing of the ... into more inaccessible and mountainous terri... the increased cost of supplies and labor, have ...e work more expensive and have resulted in a ... increased cost over the arbitrary maximum al... the Department years ago when certain max... ...tes per mile were established. This increase ...gnized by the Department, which let contracts ...tain price per day, the work not to exceed cer... ...ber of days, as bid by the deputy. This ena... ...puties to get what the work was worth.

...ver, the territory needing original survey or re... ...was much greater than the deputies available ...e to take, and this resulted in the raising of bids ...re. With the idea that the cost of surveys by ..., and subsequent examination in the field of ... the work was excessive, the contract system was ... away with last year and with the exception of ...ts already let, all public land surveys are now ... made under the classified service.

...er deputies claim that the new arrangement will ...re expensive to the Government, because men ...g under salary, and especially in Government em... are never as efficient as men working for them... Again, where surveyors have to employ men, ... teams to pack outfits, etc., it will always cost much more than when the work is done by contractors who own their own outfits and hire their own men.

It is a well known fact that throughout the West there are two scales of prices; one for residents or others buying supplies for themselves, the other (about 50% higher) for Government outfits. A contractor is always much more careful in buying than a Government employee, and conducts all his affairs in the same way, with absence of unnecessary time-killing red tape.

It would seem that the Civil Service surveyors would be more conscientious in their surveys but deputies say this will not be so. The deputy in late years is careful with all his work because he knows that the examiner will retrace 10% of it and the deputy cannot tell which this 10% will be. The Civil Service employee, who knows that his work will not be inspected, has the temptation before him to slight his work when conditions are unfavorable. If the Department should decide to send examiners to test the work of the salaried service employees that would add still more to the expense.

From the first year's trial of the new arrangement, from all that can be learned, the Civil Service surveyors have not decreased the expense by any appreciable amount. The area of land greatly in need of survey and resurvey in the Western states is still much greater than can be handled by the service, and it would seem to be advisable to restore the contract system while allowing the salaried service arrangement to continue to operate. This would give the contractors more competition as the Department would not need to accept excessively high bids. It would also result in doubling the amount of surveys possible each year.

The Bartlett Engineering Co.,
By Albert B. Bartlett.

Cheyenne, Wyo., April 27, 1911.

[The abolition of the contract system for public land surveys was advocated in Engineering News five years ago, in 1906. Effecting this reform appears to have been one of the good things accomplished by Secretary Ballinger during his term of office. As pointed out by an Oregon correspondent, however (Mr. H. A. Rands in Eng. News of July 30, 1908), examination of surveys of some sort ought to be continued, even though the work is done by government employes. If the government is charged 50% higher for supplies than private parties as a rule throughout the West, then the West needs a few elementary lessons in common honesty. If it is honest to hold up the government for 50% extra price, it would be honest to hold it up for 200% or 500% or any other amount.—Ed.]

## Testing Cement and Clay Drain Tile.

Sir: Thinking that some of your readers may be interested in the subject of cement drain tile testing, I am enclosing a couple of data sheets giving the results of some tests recently made. The first, Table I., gives the analyses of several gravels used at different Iowa tile plants and the mixtures of cement to gravel commonly employed. While fairly satisfactory results are obtained at these plants from the use of the materials and proportions herein stated, yet by the use of a couple of screens, e. g., a four-mesh and an eight mesh, and of a rock crusher, it would be possible to improve the quality of the tile or to produce a tile of equal quality at a decreased cost. Of course, to do this would require the making of screening tests and void determinations at frequent intervals, but since these do not involve the use of expensive apparatus or require extraordinary skill, the manufacturers could well afford to make them.

TABLE I.—TESTS OF GRAVEL USED IN CEMENT TILE.

| Source of Tile. | Frazer. | Goodell. | Story City. | Lake City. | Sac City. |
|---|---|---|---|---|---|
| Screening test. Percentage: | | | | | |
| Retained on 2 mesh | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Retained on 4 mesh | 8.5 | 6.6 | 3.3 | 9.8 | 19.3 |
| Passes 4 retained on 8 | 10.7 | 10.2 | 14.9 | 10.4 | 14.5 |
| Passes 8 retained on 10 | 5.6 | 7.0 | 9.4 | 7.1 | 6.7 |
| Passes 10 retained on 20 | 11.1 | 18.2 | 24.3 | 15.7 | 21.6 |
| Passes 20 retained on 30 | 16.1 | 17.4 | 18.5 | 19.6 | 15.2 |
| Passes 30 retained on 40 | 0.1 | 11.8 | 1.0 | 0.4 | 14.9 |
| Passes 40 retained on 50 | 30.6 | 15.1 | 19.1 | 20.4 | |
| Passes 50 retained on 60 | 3.9 | | 3.2 | 4.4 | 3.4 |
| Passes 60 retained on 80 | 6.2 | 14.0 | 4.0 | 7.3 | |
| Passes 80 retained on 100 | 1.5 | | 0.8 | 1.9 | 4.2 |
| Passes 100 retained on —— | 2.5 | 1.6 | 0.6 | 1.4 | |
| Clay | 2.3 | 3.3 | 1.8 | 3.1 | 2.1 |
| Percentage of voids | 28.0 | 32.0 | 31.9 | 32.0 | 32.2 |
| Specific gravity | 2.61 | 2.63 | 2.64 | 2.61 | .... |
| Proportion of cement to gravel used | 1 to 3 | 1 to 3½ | 1 to 3⅝ | 1 to 3¼ | 1 to 4 |

TABLE II.—COMPARATIVE TESTS OF 36-IN. DRAIN TILE.

| Material | 1 to 4 Concrete. Common drain | Vitrified salt glazed clay. "Culvert Pipe." |
|---|---|---|
| Quality | | |
| Thickness of wall | 3 to 3½-in. | 2½-in. |
| Breaking strength per lineal foot | 2,155 lbs. | .... |
| Crushing strength of material | 3,976 lbs. per sq. in. | 4,690 lbs. per sq. in. |
| Modulus of rupture determined from transverse tests of slabs cut from the wall of the tile | 725 lbs. per sq. in. | 1,860 lbs. per sq. in. |

These results are an average of tests on 4 to 6 specimens.

Recent investigations disclose the alarming fact that many drains are in danger of stoppage due to the breaking of the tile. This is true for both clay and cement pipe; so it will be but a short time before even this commonplace article will be designed to withstand the conditions which it is required to meet instead of being made by rule of thumb as is now the custom. Tile testing machines are being designed and experiments for determining the earth pressures on tile are under way at several state experiment stations in the middle West as well as by some of the cement companies. When the result of this work is available, there need be no excuse for the installation of defective tile.

The lack of inspections and tests for drain tile has proven very expensive to manufacturers as well as to consumers. Recently a tile failure occurred which caused a loss of several thousand dollars, which could have been avoided had the tile been properly designed instead of being made to conform to the empirical rule that the thickness should be 1/12th of the diameter. The 36-in. tile in this case were to be installed to depths ranging from 6 ft. to 14 ft.; yet no difference was made in the strength of the tile because of the varying depths. The cement tile were delivered to the trench after being allowed to set for about 30 days, and as soon as the back filling was placed the tile began to fail. Breaking strength tests were then made according to the "Iowa standard method" which showed that the average breaking strength of the tile was about 2,200 lbs. per lin. ft., while the maximum load of earth at 100 lbs. per cu. ft. would be about 4,000 lbs. Whether or not the entire weight of the back filling was directly borne by the tile is another problem; but the tile failed at depths where the calculated weight of earth was about the breaking strength of the tile. Table II. gives the results of tests on the cement tile and the vitrified tile which replaced them. As will be noted, the quality of the concrete is fairly good for the age of the tile, but the pipe should have been made thicker or have been reinforced.

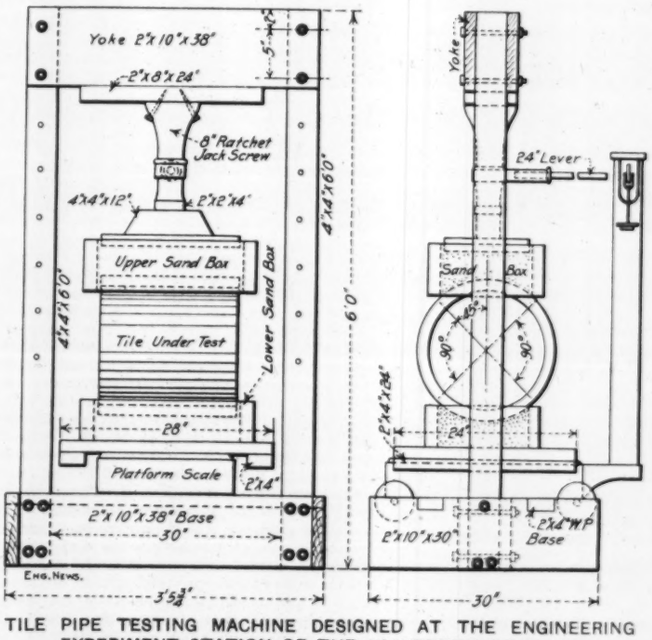
Another factor which must be considered in the design of tile is the method employed in excavating the trench. The earth pressures in a machine dug trench with smooth vertical sides will be different than in one cut by hand which is wider at the top and narrowed in cutting until the desired bottom width is secured. The difference is accentuated if the machine is equipped with a conveyor for backfilling as fast as the tile are installed, while the hand laid tile are usually covered by a couple of spadings and allowed to remain thus for several weeks, in which time rains and water flowing in the trench will bed the tile quite thoroughly.

The many problems relating to tile construction are worthy of attention and will no doubt be the subject of much study in the future.

A. O. Anderson.

Lake City, Iowa, April 8, 1911.

[In our issue of March 2, 1911, p. 258, we reprinted a paper by Prof. A. Marston, Dean of Engineering at the Iowa State College, and Prof. Anderson, the writer of the above letter, who is Assistant Engineer of the Engineering Experiment Station, on "Standard Tests of Drain Tile and Sewer Pipe." The specifications drawn by them and given in this paper have now been adopted by the Association of Iowa Cement Users, the Iowa Brick and Tile Manufacturers' Association, the Iowa Drainage Association and the Iowa Engineering Society.




TILE PIPE TESTING MACHINE DESIGNED AT THE ENGINEERING EXPERIMENT STATION OF THE UNIVERSITY OF IOWA.

A simple machine for applying the loading test is here shown. It was designed at the Engineering Experiment Station by Prof. Anderson. Its chief essentials are an ordinary platform scale of 2,000-lbs. capacity, and an 8-in. ratchet jack. The pressure loading is applied at the top and bottom through sand boxes, covering an arc of 45° each. The scale rests on a base to which is attached a yoke of 4 × 4-in. timbers, within which the jack-screw is operated. The details of the frame and method of placing the pipe are clearly shown in the accompanying drawings.

The depth of sand in the bearing boxes, method of applying the load and the calculation of the total breaking load are given in the specifications above referred to—Ed.]

## The Mechanical Handling of Coal and Ore: Work of Alexander E. Brown.

Sir: The recent death of Alexander E. Brown has removed from us the man who created the combination of hoisting and conveying as applied to coal and ore handling.

He entered, about 30 years ago, into a new and untried field, and his early struggles in attaining success rank him with the "long-to-be-remembered" men of the world. Wherever the great industry of mechanical transference and the achievements in this art shall be mentioned, his name must always be recalled.

When he started to become a "captain of industry" the little wheel-barrow with its 200-lb. load, wheeled along a narrow plank to the top of the ore pile, was the only mechanism. Men following one another so closely as to form an almost continuous line, both out and return, were the conveying power of the day. The great cone of ore thus slowly formed was like an ant-hill, and the men were like ants.

Looking into the future he prophesied the possibility of 150 barrow loads being moved by one man in a small fraction of the time that one barrow load was then carried. To-day almost before the barrow man could have started up the incline with his load, 15 tons of ore have been conveyed and dumped.

Then the cost was 35 cts. or even more per ton; to-day it is only a few cents. Then a vessel like those of to-day would have required almost as many days to unload as to-day it takes hours. To-day 12,000 tons are unloaded between four and five hours. Now the vessel itself, its officers, its crew, all, accomplish many-fold more as a result of this invention. Not only is there the saving in time and labor of unloading, but there is greater efficiency in the whole transportation system of the Great Lakes. The value of the terminal and the output both of the mines and of the furnaces have been directly increased through this ore and coal hoisting and conveying machinery.

A large manufacturing plant in Cleveland and numerous factories, not only in the United States, but all over the world, in Germany, England, Holland, France, are a result of his genius. To indicate how closely his work has been followed in many a foreign city, the great cantilever cranes, with every rod, truss and girder silhouetted against the sky, are often such exact copies of his designs that one would assert that they had been constructed at his Cleveland works.

It may be said that there are few civilized nations, if any, which have not sent their engineers to Cleveland to inspect and study these wonderful hoisting and conveying machines. The offices of this Cleveland company were established in all the great cities of Europe and even in South Africa.

The splendid results of his inventions were not achieved without struggles. In fact, his comparatively early death may be said to be directly attributed to the intense energy which he devoted to his work. It was for many years his life. No detail business, design or production was too small for his attention.

At one time, when the writer was talking with Mr. Brown about his early struggles, he told in his interesting modest manner, the story of the installation of his first machine upon the ore docks of Cleveland. It was probably like all first machines, not yet the perfect piece of mechanism which it later became; but was the best that could be constructed at that time, with the limited knowledge as to the severe requirements of daily service.

This machine not only had to sustain its own burdens under the direction of unskilled operators, but there was the opposition of the stevedores. On account of the many vexatious breakdowns and delays due to causes, many of which were beyond the designer's control, the president of the company which had ordered the machinery, finally told Mr. Brown that on account of these delays and the demurrage of the vessels it would be necessary for the machinery to be removed. Mr. Brown knew it would be a success and his faith was still strong within him; yet what a blow it must have been! He was not discouraged, and finally prevailed upon the president to continue the trial. Its value soon after was fully recognized and Mr. Brown said that nothing ever gave him so much pleasure, when, after the long trial, the saving in expense and time was so demonstrated that this same president gave an order for 14 machines.

Many other trials and temporary discouragements might be mentioned, but all finally resulted in one glorious success; and to-day the memory of Alexander E. Brown stands pre-eminent as one who was a creator of a new industry which has not only benefited the city of Cleveland, but many other cities. Moreover, that great industry which concerns itself with all other industries, Transportation, has also been assisted in its wide reaching development through this rapid and economical handling of material.

H. McL. Harding,
Consulting Engineer.

20 Broad St., New York City, May 8, 1911.

## Kutter Formula Values for Rock Channels.

Sir: In this morning's Engineering News Mr. R. Mugnier, of Lamar, Colo., makes enquiry respecting "the proper value of $n$ to use in Kutter's formula in determining the mean velocity of water in an open cut in rock."

Mr. Mugnier refers (1) to Flynn, as working out, in his Hydraulic Tables, an example where $n$ "is shown equal to 0.0225," (2) to a report of the Reclamation Service on the Truckee-Carson project as showing unlined rock sections where "the coefficient $n$ is equal to 0.025," and (3) to engineers who "claim that from personal experiments $n = 0.035$ should be the coefficient in use."

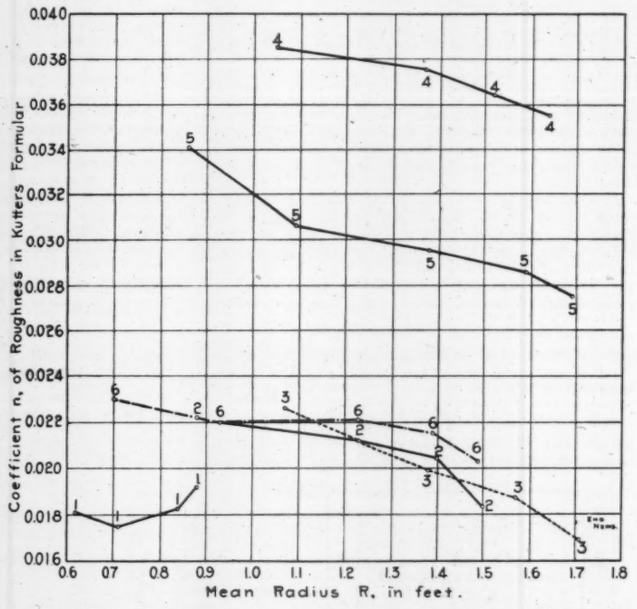



DIAGRAM OF VALUES OF COEFFICIENT OF ROUGHNESS ($n$) FOR KUTTER'S FORMULA, IN GROSBOIS CANAL, LINED WITH RUBBLE MASONRY.

(Data from "Flow of Water," transla ted from Ganguillet & Kutter by Rudolph Hering and John C. Trautwine, Jr.)

Reference to Flynn's Hydraulic Tables (p. 53) shows that their author merely assumed that 0.0225 was "a near approximation to the value of $n$ for the rock cutting." In a paper on the Truckee-Carson project, in Engineering News of Oct. 18, 1906, by Mr. W. P. Hardesty, C. E., Asst. Engr., U. S. Reclamation Service, the value 0.025 quoted by Mr. Mugnier, is mentioned (p. 393) in such a way as to indicate that, as in Mr. Flynn's case, it was merely assumed for purposes of calculation.

The value 0.035 given by Mr. Mugnier as based upon the personal experience of engineers is the only apparently experimental value I have seen given for cuttings in rock. In the table of gagings contributed by Mr. Rudolph Hering to our translation of Ganguillet and Kutter's "Versuch," values of $n$ are given for "channels lined with rubble masonry," which may be taken as an artificial and unduly smooth imitation of a rock cutting. These values range all the way from 0.0138 to 0.0385, the highest values (0.0355 to 0.0385) obtaining in Series 4 for the Grosbois canal, where the bottom was "stony," and one slope was "protected by rock." In untrimmed and unlined rock cuttings, the value might be expected to range say from 0.0150 or 0.020 to 0.050.

In short, there is no "proper" value of $n$ for rock cuttings, as there is (strictly speaking) no "proper" value of $n$ for earth or for brickwork; for the value of $n$ depends not upon the classification of the [illegible] under this or the other head, but (1) upon the rou[illegible] of the channel (compare Series 5, in accompanyin[illegible] and diagram, with Series 6, in which the stonewo[illegible] been "scraped and cleaned with great care, previ[illegible] experiments") and (2) upon this roughness relative to the dimensions of the channel, a point which is pe[illegible] too often overlooked.

If, for instance, the channel of the Hudson Rive[illegible] New York, could be first smoothly finished in nea[illegible] ement, and then paved with cobble-stones, 6 in[illegible] diameter, the resulting increase in the value of $n$ [illegible] be much less than if a channel 3 ft. wide and a foot [illegible] were similarly treated.

This is indicated, in the accompanying tabl[illegible] and diagram, by five (Nos. 2 to 6) of the six series [illegible] sults in the Grosbois canal, given in our table, [illegible] of which the value of $n$ is seen to diminish as th[illegible] of the channel (indicated by the mean radius, [illegible] creases. The other cases in our table are less c[illegible] lusive in this respect, some of them indeed (like G[illegible] series No. 1) indicating a reverse tendency.

deal, in general, with channels smaller than the [illegible] bois, and of less range as to size.

The difficulty, in the use of the Kutter formula, [illegible] of any other hydraulic formula employing experi[illegible] coefficients, lies in the selection of the value o[illegible] the coefficient proper to the particular case in hand; [illegible] it was for the purpose of meeting this difficulty tha[illegible] Mr. Hering, with characteristic painstaking, prepared the table mentioned, which gives values of $n$ as deduced from more than 1,200 gagings, in large and small ch[illegible]nels and pipes of widely differing materials and con[illegible]tion. By consulting such a table and selecting the case most nearly resembling the one in hand, the engineer arrives at a value of the coefficient which may be taken, with some confidence, as being approximately the one proper to the given case; his confidence increasing with the number of cases included in the table, with the minuteness of their description, and with the care manifested in their collation and study.

If Mr. Mugnier will kindly put us in the way of learning the particulars of the experiments of the engineers whom he quotes as obtaining values of $n$, the service will be appreciated by Mr. Hering and by myself.

John C. Trautwine, Jr.

257 South Fourth St., Philadelphia, Pa., April 20, 1911.

VALUES OF KUTTER'S $n$ IN GROSBOIS CANAL LINED WITH RUBBLE MASONRY.

(From Darcy and Bazin, "Recherches Hydrauliques," Paris, 1865.)

| Series. | Character of Surface. | $R$. ft. | $n$. |
|---|---|---|---|
| 1 | Roughly hammered stone masonry. | 0.88 | 0.0192 |
| | | 0.84 | 0.0182 |
| | | 0.71 | 0.0175 |
| | | 0.62 | 0.0181 |
| 2 | Masonry in rather bad order; some mud and broken stones on bottom in many places. No grass. | 0.88 | 0.0222 |
| | | 1.23 | 0.0212 |
| | | 1.40 | 0.0204 |
| | | 1.50 | 0.0183 |
| 3 | Same as series 2. | 1.07 | 0.0226 |
| | | 1.38 | 0.0190 |
| | | 1.57 | 0.0187 |
| | | 1.71 | 0.0169 |
| 4 | Stony bottom; one slope protected by rock. Trapezoidal. Very little vegetation. | 1.05 | 0.0385 |
| | | 1.37 | 0.0375 |
| | | 1.52 | 0.0364 |
| | | 1.64 | 0.0355 |
| 5 | Spillway. Roughly hammered masonry, set dry, quite well preserved but covered with slime and grass. Trapezoidal; flat. | 0.86 | 0.0341 |
| | | 1.09 | 0.0306 |
| | | 1.38 | 0.0295 |
| | | 1.59 | 0.0285 |
| | | 1.69 | 0.0275 |
| 6 | Same as Series 5; but stonework scraped and cleaned with great care previous to experiments. | 0.70 | 0.0230 |
| | | 0.93 | 0.0220 |
| | | 1.23 | 0.0221 |
| | | 1.39 | 0.0215 |
| | | 1.49 | 0.0203 |

## Notes and Queries.

C. N. B., Boston, writes:

In connection with driving piles with a double acting steam hammer of the Monarch type, have you any information as to the comparative effects of blow of this type of hammer as compared with the drop or single acting steam hammer? In short, what would be the effective safe loading formula for piles driven with this type of machine?

It is well known that the resistance of piles to driving is very much less when driven by rapid blows than when the blows are delivered slowly. We know of no reliable formula for bearing power, when piles are driven by the double-acting type of steam hammer. The equivalent height of drop of the hammer can be computed of course if the mean effective pressure of steam in the cylinder on the downward stroke is known; but the greater rapidity of the blows introduces an uncertain factor. We should think the safe course would be to subject certain piles to test loads.

J. R. G., Louisville, Ky., writes: "Can anyone give information regarding any surveying or engineering corporation which guarantees land surveys?"

Attention is called to an error in grouping the drawings of the article "The Mechanical Handling of Package Freight," by M. B. Waterman, in our issue of May 11, p. 566-567. The freight transfer station, Fig. 2, is correctly shown as to ground plan, but this should be accompanied by the side elevation and cross-section on p. 566. Similarly, Fig. 3, should be made up of the ground plan on p. 567 (Fig. 3) and the side elevation and cross-section printed on p. 566 (erroneously) as part of Fig. 2.

## The Development and Treatment of Locomotive Boiler Tubes.*

By F. N. SPELLER.†

The boiler industry owes much to the railroads for its development; in fact the invention of lap welding may be traced to the necessity which arose on the building of George Stevenson's first locomotive for a tube which would be safer and stronger than the butt welded tube, the only one made at that time.

Seamless steel tubes were introduced about 1886 and established a new standard of strength and ductility and endurance under many conditions of service. Later on a satisfactory grade of soft steel was produced which could be lap-welded like charcoal iron and this also has been much improved, so that we now have practically three classes of tubes for locomotive service; (1) charcoal iron (lap welded); (2) steel (lap welded); (3) seamless steel.

Charcoal iron formerly was manufactured from a special grade of pig iron made in a small blast furnace using charcoal fuel. The product of this furnace was charged into the refinery where about one-half of the impurities were oxidized and fluxed away, the metal being subsequently treated in lots of 300 lbs. or so in a slightly modified type of the old catalan forge with charcoal as fuel. We abandoned the making of charcoal-iron tubes about two years ago in favor of lap-welded and seamless steel, which had by that time been proved a fit substitute and in some respects decidedly superior to the older material.

It is understood, of course, that, when we speak of "steel" here, we refer more to the method of manufacture than to the finished product. The steel used in the manufacture of tubes, as a matter of fact, is a purer form of iron than that made by the charcoal process, and like the older metal cannot be tempered.

A special grade of Bessemer steel was at first used in the manufacture of lap welded tubes, on account of its superior welding quality, but later on had to be abandoned as under some conditions it was found to develop brittleness in the beads after the tubes had been in service some time. The substitution of basic open-hearth steel, low in carbon and with less than 0.05% phosphorus and sulphur, has been found, after more than two years trial, to entirely do away with any tendency of this kind. As now made there is little difficulty in securing a strong weld with this steel. Seamless and lap-welded steel tubes are now made from practically the same grade of soft basic open-hearth steel.

RESISTANCE TO CORROSION.—The manufacturer should furnish a tube in the best possible condition to withstand corrosion and pitting. That is, the metal should be as uniform in composition and density as it is possible to make it. Much can be done to lessen the tendency to pitting by proper attention to the making of steel and to the way it is worked. We have been experimenting on this problem now for several years and have gone to considerable trouble in the matter of testing and inspection of material and in the process used for manipulating the steel, so as to produce a tube which will resist corrosion as well as iron can be made to do so. Judging from the reports of comparative service tests which have been received, steel so made is, in this respect at least the equal of the best charcoal iron.

After all, however, the solution of this problem is largely in the hands of the user. Iron or steel will corrode in spite of anything that can be done if certain material is in solution in the water, particularly dissolved oxygen or carbonic acid. By the removal of these harmful agents, corrosion may be reduced to practically nothing. It is generally understood nowadays that water conditions have everything to do with corrosion, and the simplest solution of the problem is to treat the water with the object of making it as harmless as possible. The development of the modern tube to withstand corrosion and the treatment of water have together practically eliminated this trouble, so that it is rarely the case that tubes fail nowadays through pitting.

LEAKING IN THE FLUE SHEET.—The construction and handling of the engine has so much to do with the trouble experienced from leaky flues that it is difficult to determine how much, if any, of the responsibility for this should be placed on the tube material. If railroad engineers will tell us what qualities are required in the tube to make it hold tight in the flue sheet, we will be glad to follow their suggestions as closely as possible. At the present time the steel tube is made as stiff as possible, consistent with the best welding quality and ability to stand up successfully under expansion and beading in the tube sheet.

STRENGTH AND DUCTILITY OF MATERIAL.—The tube should be of such quality as to stand repeated tightening in the flue sheet without cracking or showing undue evidence of fatigue, nor should these weaknesses develop during the life of the flue in service. The material found best adapted to give these properties is a special grade of soft open-hearth steel carrying not over 0.05% phosphorous or sulphur.

WELDABILITY.—The quality of the metal and method of handling are equally important in safe ending. Soft steel has been found somewhat harder to weld than charcoal iron, but it has been greatly improved in this respect. The necessity for a good welding quality steel is of first consideration in making locomotive tubes so that they may be easily safe ended. This point has received a great deal of study, especially in the manufacture of lap-welded tubes where it is, of course, one of the first essentials to manufacture. Charcoal iron carries considerably more impurities than soft open-hearth steel, and these impurities form a self-fluxing mixture which facilitates welding.

Railroad specifications have been so tightly drawn on composition, in some cases, as to work against the production of a good quality of steel for locomotive boiler tubes by calling for unnecessarily low phosphorus and sulphur. There is now very good reason to think that a mistake has been made in this direction and that the general welding quality of the steel would be much improved, and the steel at the same time would lose nothing in other respects, if the maximum phosphorus and sulphur limits were both raised to 0.05%. With producer gas, now generally used of necessity, it is a very difficult matter to keep the average sulphur in the heat below 0.035% and in order to remove this sulphur in the open-hearth furnace the steel has to be held and worked in

Standard Test Specimens of Lap-Welded Steel Boiler Tubes; National Tube Co.

(The crop end, "a," is laterally compressed in a special testing machine by the first operation, as shown by piece "b." The specimen is then compressed transversely and a flange turned on the top, as on the piece "c.")

such a way as to frequently leave it dry and difficult to weld.

In practice, before the steel can be welded, a fluid cinder must be formed on the surfaces which are to be united. The metal will be burned and destroyed if heated too far above the point at which this cinder should flow. We endeavor to have the range of temperature between the cinder-forming and steel-burning points as wide as possible so as to assist in lap welding and to give the largest margin of safety in safe ending. Considering the variety of the requirements it seems to us that the composition of the metal should be left largely to the discretion of the manufacturer so far as is consistent with a certain specified standard of physical quality in the finished tube. We frequently go to the trouble of re-phosphorizing for the purpose of improving the fluxing and welding quality of our steel.

The method of "safe ending," we have said, has as much to do with obtaining satisfactory results as the material, but we will not attempt to lay down specific rules as to construction of the furnace and heating, for many of the practical shop men present who are welding flues every day are much more able to discuss this side of the problem. However, there are a few broad principles on the heat treatment of tube steel which should be taken into consideration. The preliminary heating of the body tube preparatory to flaring out the end should be carried to a bright orange color judging by good shop light, 1,750° F. In the case of steel on steel, if the body tube is allowed to cool black, after heating to this temperature and inserting the "safe-end," the grain structure will be refined and the metal put in much better condition for the welding operation which follows. Moreover, if the preheated body tube is returned to the furnace without cooling the metal may be crystallized or burned before the "safe-end" has been heated hot enough to weld. Should there be any considerable difference in thickness between the "safe-end" and body tube, it is evident that there is again a risk of over-heating the one before the other is sufficiently heated to weld. If the body tube is returned to the furnace while red hot and the "safe-end" is at the same time a gage or two heavier, there is, of course, all the more chance of crystallizing or burning the body tube at or near the weld. Taking unnecessary risks of this kind often explains subsequent failures which should not be charged up to the flue maker.

It is not unusual for a flue welder who has never handled steel to have trouble for a few days. Remembering the above points and using his experience to the best advantage as to the condition of his furnace, the character of the flame, temperature, etc., the average man will soon be able to do equally reliable work with steel as with charcoal iron as the experience of welders all over the country will show.

UNIFORMITY OF MATERIAL.—This is a quality which the tubes should have in a high degree, both as to physical and chemical properties. There is no difficulty as to the average steel tube nowadays standing the Master Mechanics' tests made on one sample out of each hundred tubes. We have, however, recently designed a machine to make the flange, crushing down, and flattening test on each end of every tube in the manner shown in the accompanying figure. This gives assurance both as to the character of the metal in each individual tube and also, in the case of lap-welded tubes, as to the welding quality being satisfactory. Steel tubes are now made in one grade of material suitable for either body tube or "safe-ending."

*From a paper read before the Pittsburg Railway Club, April 28, 1911.

†Metallurgical Engineer, National Tube Co., Pittsburg.

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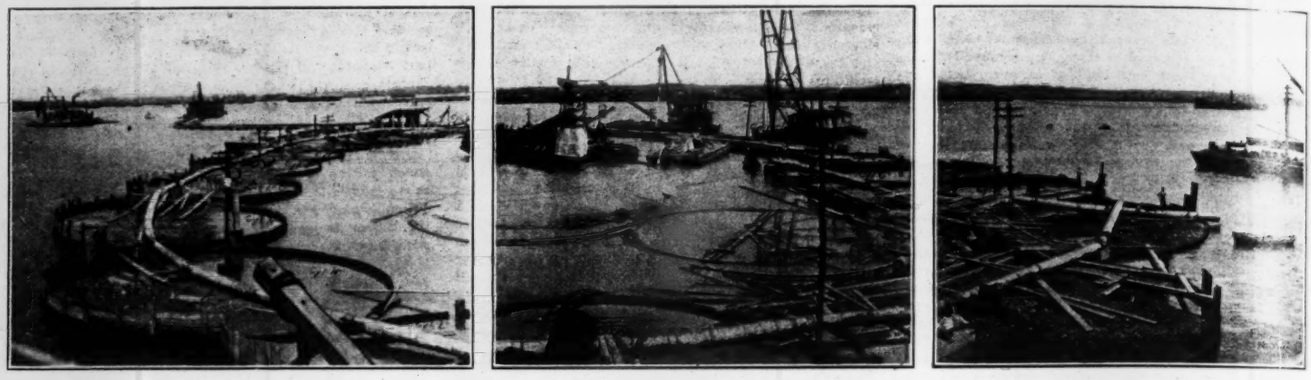
A DEPARTMENT OF CONSERVATION FOR NEW York State, in which would be consolidated the existing (1) Forest Purchasing Board, (2) Forest, Fish and Game Commission and (3) State Water Supply Commission, is proposed by a bill now before the New York Legislature. The new department would be in charge of a single Commissioner of Conservation, who would have all the powers and duties of the displaced commissions and commissioners, except as certain of his decisions or acts would be subject to the approval of a Conservation Advisory Board of five members. This Board would include the Commissioner of Conservation as Chairman, the Lieutenant-Governor, Attorney-General, State Engineer and Surveyor and the Superintendent of Public Works. The Board would act only on recommendations of the Commissioner of Conservation, and its acts would be subject to approval by the Governor. The particular matters subject to the approval of the Advisory Board would be the purchase of land, the approval of plans for regulation of stream flow for the development of hydraulic power, and grants of water rights and privileges for either municipal or private purposes. The Commissioner of Conservation would be appointed by the Governor, with the approval of the Senate, and receive an annual salary of $8,000 a year and necessary expenses. He would appoint a Chief Deputy Commissioner, a secretary, a confidential secretary and nine deputy commissioners, besides filling minor offices. The deputy commissioners would be subject to removal by the Commissioner, at his pleasure. In February of each year the Commissioner would be compelled to report to the Governor all positions in the department necessary for the conduct of business, with the salary pertaining to each, and the Governor would then approve or disapprove of the positions and the salaries. Each of the deputy commissioners would head one of the following Bureaus: Administration; Water Storage, Power Development and River Improvement; Water-Supply; Parks; Forestry; Inland Fisheries; Marine Fisheries; Fish and Game Protection; Engineering, and Law. The Chief Deputy Commissioner, the Secretary to the Department and a deputy commissioner would have all the powers of the Commissioner, subject to the discretion of the Commissioner, except as a member of the Advisory Board and the Fish and Game Board. The bill setting forth the organization, powers and duties of the proposed Department of Conservation makes a pamphlet of 72 open-spaced pages. Apparently the bill incorporates most of the provisions of existing laws governing the commissions it is proposed to consolidate into the above-named department. Additional powers seem to be given at some points to facilitate the development of water storage and power for municipal and private purposes, including the utilization of power from waters associated with the State Canal System. An accompanying bill authorizes a $20,000,000 state bond issue "for the construction of works to conserve and develop the waters of the state by the state."

## Progress on the Cofferdam Around the Wreck of the Maine.

The half-tone reproduced on this page shows a panorama view of the cofferdam around the wreck of the "Maine" in Havana harbor, as it was during the last week of April. At that time all of the cylinders had been driven and most of them had been filled with clay, so that the dam was almost ready to be pumped out. During the first week in May, however, a leak developed in Cylinder N, the second cylinder in the left-hand section of the view, and the repairs now necessary will probably retard the work for at least another week. It is expected now that emptying the cofferdam will be started the last week in May. It is intended to lower the inside level by stages, exposing each deck of the wreck successively and working on the removal of all the removable parts there before pumping down to the next deck. In this way it is hoped to let the sections of the dam acquire a set, as it were, instead of subjecting them immediately to the total pressure due to the full depth of water.



VIEW OF THE COFFERDAM AROUND THE WRECK OF THE "MAINE."

Taken the last week in April, 1911.

(The circles showing in the interior of the dam are the floating wooden forms used in making the cylinders.)

The work of driving and filling the cylinders has progressed much more satisfactorily than was expected. In driving difficulty has been experienced in several cases in making the closure, which has occasionally been too large to be filled by the closure piles. In all but one cylinder, however, the final piles driven were strong enough to pull the spread together and successfully make the circle; but in the case of Cylinder B, one of the earliest driven, the circumferential tension was too great and the jaw of the closing pile parted. In our issue of last week, p. 583, we reported that a similar accident had occurred in Cylinder N, but it has since been learned that the trouble there was somewhat different.

Cylinder N is located at a place where considerable debris was blown from the ship at the time of the explosion. Already there have been taken up from its vicinity by divers a large sheet anchor and a portion of a turret. It is now reported that one of the sheet piles in driving encountered some of this sunken material and was split up through the web. The split was not discovered until filling was nearly completed, when the bursting pressure became so great as to lengthen the opening clear to the top, straightening out the sides of the cylinder for some distance back from the break and allowing a portion of the clay filling to escape. It testifies to the solidity of the fill, however, that the clay on the far side of the cylinder stood on a steep slope, and only about half the filling, in plan, blew through the opening.

The engineers in charge have been agreeably surprised by the good quality of the clay fill. As shown in the view it is being pumped into the cylinders from a hydraulic dredge through a pipe laid around the whole cofferdam, with an opening made at whatever cylinder is being filled. The hydraulic dredge (which is the right-hand of the two dredges shown in the left section of the view), is one of the most powerful of its type, with a rated capacity in ordinary mud of 12,500 cu. yds. per day. It is now working in the hard clay which underlies the softer surface bottom of Havana harbor, and can only pump of this material some 1,500 cu. yds. per day. To the left of the hydraulic dredge may be seen a clam-shell dredge, which with difficulty has been excavating some 300 cu. yds. per day. This clay is mostly of a coral sand formation which dries out very rapidly, when pumped into the cylinders. In many of the cylinders there were placed during filling loose wooden boxes extending from bottom to top, and with the pumps now available, it has been impossible to raise any muddy water from them, proof that the filling is solid clear through to the bottom, so solid that no percolation is coming through the filling. After the surface drying has taken place, which occurs in a very short time, the clay is quite hard enough to bear the weight of a man walking upon it.

So far as can be learned no rip-rap has as yet been placed either inside or outside the dam.

We are indebted to Col. W. M. Black, Corps of Engineers, U. S. A., who is chairman of the board having charge of the work, for the accompanying photograph and information.

## A General Law Authorizing the Commission Plan of City Government in New Jersey.

The Commission plan of city government is made possible of adoption by any municipality in the State of New Jersey by an act passed by the Legislature of that state and approved by the Governor. In the main, the act follows the accepted lines of commission plan state legislation and charters. One notable exception, which was the subject of much controversy in the Legislature, is the provision that to carry the act into effect in any municipality, the votes cast in its favor at the stated election must be equal to at least 30% of the number of votes cast for members of the State Legislature at the last preceding general election. It was originally proposed by the opponents of commission-plan legislation to make the percentage 40.

The number of commissioners provided for in the act is five for municipalities of 10,000 population or over, and three for those under 10,000, but the commissioners in either class of cities may decrease the number from five to three or increase it from three to five, respectively.

The commissioners would hold office for four years and all commissioners would go out of office or stand for reelection at the same time. All nominations to commissionerships would be made by a petition. At the primary election, double the number of candidates necessary to fill the commissionerships would be chosen, and at the regular election following the choice would lie between these candidates alone. No party designations would be permitted on either primary or election ballots.

All administrative, judicial and executive powers now possessed by mayors, the city councils and all other executive or legislative bodies in any city adopting the commission plan would be vested in the commissioners, with the exception of powers pertaining to educational matters, which are not affected by this plan. The commissioners would have full power to [illegible] such subordinate boards and appoint such [illegible] as they saw fit, and subsequently to abandon any board or remove any officer "at any time for cause, after public hearing." On the accession of commissioners to office after the adoption of the plan, all offices, whether filled by election or appointment, would become vacant, except the employees of police or fire departments, war veterans or any other officials now protected by the state "tenure of office act," or any offices subject to civil service rules in those cities which have adopted the Civil Service Act of 1908.

On assuming office, the mayor would become Commissioner of Public Affairs, and the commissioners would decide which of them should head the following additional departments: Revenue and Finance; Public Safety; Streets and Public Improvements; Parks and Public Property. The salaries of the commissioners in all cities of the first, second and third class would range from $5,500 for the mayor and $5,000 for the other commissioners in cities of over 200,000 population, down to $75 and $50, respectively, for places under 500 population. In cities of the fourth class, the maximum salaries stated above would apply to cities of over 90,000 population, and for the smaller cities the salaries would be considerably higher than for smaller cities in the first to third classes, diminishing to only $500 and $250 for the president and other members, respectively, in places of under 500 population. Provision is made in the act for the initiative, the referendum and the recall.

All officers and employees are to be elected or appointed "solely with reference to their qualifications and fitness, and for the good of the public service, without regard to their political faith or party affiliations." Election expenses are to be published.

The commissioners are given the usual powers to enact and enforce all ordinances necessary for the protection of life, health and property, for the general welfare, etc., "and shall have all powers necessary for" the government of the municipality in question "not in conflict with the laws applicable to all cities of" the state or contrary to the provisions of the state constitution; provided that no increase of the net bonded indebtedness in excess of 10% of the assessed valuation of all the property of the city shall be valid unless first approved by popular vote. Franchise ordinances require for passage one vote more than the majority of the commission, that is, four out of the five commissioners in a five-commissioner city and all the commissioners in a three-commissioner city.

Any city which has tried the commission plan of government for six years may return to its original charter, provided the majority of the citizens vote in favor of doing so after the proper filing of the petition for an election, which petition is to be signed by 25% of the legal electors of the city.

PANAMA CANAL EXCAVATION during April totaled 2,691,7[illegible] yds., a daily average of 112,156 cu. yds. for the [illegible] working days. The amount of concrete placed during the month was 138,923 cu. yds. and 655,14[illegible] yds. of fill were placed in dams. The rainfall was 8[illegible]6 ins.

A COAL MINE FIRE, May 11, in the Boston mine of the Delaware & Hudson Co., at Larksville, Pa., three miles from Wilkes-Barre, caused the death of five men. Reports state that the fire broke out on the night of May 10 but was quickly gotten under control, so that the men remained at work. After midnight, when only a small number of men were at work, the fire was discovered to have again become dangerous.

OVERLAPPING TRAIN ORDERS are assigned in press reports as the cause of the butting collision of two freight trains on the Boston & Maine R. R., May 14, two miles south of White River Junction, Vt. The accident occurred on a curve during a fog. Four trainmen were killed, and three others injured. Both locomotives and 35 cars were wrecked, and the wreckage was partially consumed by fire.

A DERAILMENT on the Denver & Rio Grande R. R., May 10, at Rex, Colo., caused the death of two passengers and the injury of many others. The accident is ascribed to weakening of the roadbed by flood water in the Eagle River. The entire train of six cars left the rails. The chair car and a tourist sleeper went into the river.

IN AN AEROPLANE ACCIDENT at San Antonio, Texas, on May 10, Lieut G. E. M. Kelly, U. S. A., was killed. A trial flight was being made with a Curtiss biplane flyer, and the aviator was about to land when he lost control of the machine. The machine made a heavy landing which threw on the power again, starting the machine ahead. The aviator was thrown forward onto his head and the flyer was piled on top of him.

REDUCED RATES FOR ELECTRICITY have been voluntarily made by the New York Edison Co. and its allied concern, the United Electric Light & Power Co., for its service in the boroughs of Manhattan and The Bronx. There are three simple schedules, as follows, under which the entire service of these companies will be rendered—with the exception of supply in immense quantities or for "breakdown" service of isolated plants:

GENERAL RATE:

| | | |
|---|---|---|
| The first | 250 KW.-hrs. of monthly consumption at | 10 cts. |
| The next | 250 KW.-hrs. of monthly consumption at | 9 cts. |
| The next | 250 KW.-hrs. of monthly consumption at | 8 cts. |
| The next | 250 KW.-hrs. of monthly consumption at | 7 cts. |
| The next | 500 KW.-hrs. of monthly consumption at | 6 cts. |
| For the excess over | 1,500 KW.-hrs. of monthly consumption at | 5 cts. |

These rates include the supply and renewal of all standard incandescent lamps, and carbons for and trimming of arc lamps, or an equivalent allowance in the price of tungsten or tantalum lamps. Where of advantage to the consumer, power may be included under the general or wholesole rate.

Consumers, making a yearly contract, who agree to an average monthly use of not less than 1,500 KW.-hrs., including power if desired, may renew their incandescent lamps, supply carbons for and trim their arc lamps, and otherwise care for their installations, and for so doing will receive a special discount of ½-ct. per KW.-hr.

POWER RATE:

| | | |
|---|---|---|
| The first | 200 KW.-hrs. of monthly consumption at | 9½ cts. |
| The next | 200 KW.-hrs. of monthly consumption at | 8 cts. |
| The next | 2,500 KW.-hrs. of monthly consumption at | 6 cts. |
| For the excess over | 2,900 KW.-hrs. of monthly consumption at | 5 cts. |

AUTOMOBILE, STORAGE-BATTERY AND REFRIGERATION RATE:

| | | |
|---|---|---|
| The first | 2,500 KW.-hrs. of monthly consumption at | 5 cts. |
| The next | 2,500 KW.-hrs. of monthly consumption at | 4 cts. |
| For the excess over | 5,000 KW.-hrs. of monthly consumption at | 3 cts. |

This rate is dependent upon a minimum monthly consumption of $25, and includes the agreement that where the use of current does not exceed 50,000 KW.-hrs. monthly, the cost shall not exceed $1,500.

The reduction from the present rate of 10 cts. per KW.-hr for small and medium-size customers, works out to benefit all consumers using motors and to all others using energy to the value of $25 per month. Credit, for this action on the part of these public-utility companies, is assumed by the Public Service Commission for the First District.

AN EXHIBITION OF CITY PLANNING will be held at the City Hall, Philadelphia, from May 15 to June 15, 1911. The opening of the exhibit will be coincident with that of the Third National Conference on City Planning, which is to be held at Philadelphia May 15 to 17. The City of Philadelphia some months ago appropriated $10,000 in behalf of the exhibition and every effort has been made by a local committee of officials and citizens to make the exhibit a success. Hon. John E. Reyburn, of Philadelphia, is chairman of the committee. Inquiries regarding the exhibit should be addressed to Mr. W. Templeton Johnson, Assistant Secretary, City Hall, Philadelphia, Pa.

THE FIRST DECISION ON TELEPHONE TRAFFIC by the Interstate Commerce Commission, which was given power to regulate telephone rates by the last session of Congress, has recently been published. The complaint calling out this decision showed that the subscribers of the local exchange at Drummond, Md. (a suburb of Washington), were charged $24 for residence service before consolidation with the Chesapeake and Potomac Telephone Co., serving Washington. After consolidation the old customers were kept at the old rate, while new ones were charged the higher Washington rates for the same service. The Commission has held that:

The contracts between old subscribers and the defendant, even though valid when made, cannot, after Congress has undertaken to regulate the rates and practices of telephone companies, be accepted as now justifying different charges as between different subscribers, similarly situated, such undue discrimination being forbidden by the act.

It is expected that the solution of the difficulty lies in raising the rates of old customers, under conditions of such consolidations, so that discriminations shall disappear.

THE RIVERBANK SUBWAY, proposed as an extension of the Boston Elevated Railway system and described in Engineering News, Jan. 26, 1911, p. 100, is the subject of a joint report (May 1) of the Massachusetts Railroad and Boston Transit Commissions to the Legislature. It is recommended that the plans for building this subway be abandoned. This project was to relieve the congestion on Boylston St., which has a traffic of 456 cars per hour, maximum. The line would pass from a terminal at Park St., under the Common to the Charles River and thence parallel with the river to Charlesgate. The length would have been 1¾ miles and the estimated cost, unequipped, was $3,000,000. This subway was to have a capacity of 500 cars per hour and would have saved ten minutes between Boston and parts of Newton, Brookline, Waltham, Watertown, etc.

In place of the Riverbank subway, a new subway is recommended to run under Boylston St., from the intersection of Commonwealth Ave. and Beacon St. to the Park St. terminal, a distance of about 1¾ miles. The estimated cost is $1,000,000 more than the Riverbank line. The same territory would be benefited as by the old plan.

## Personals.

Ewing & Stone, civil engineers, 1742 Monadnock Block, Chicago, is a new firm organized to carry on the business of the late W. B. Ewing.

Mr. W. Kitson, until recently with the firm of Smith, Kerry & Chace, of Toronto, Ont., has been appointed Town Engineer of Battleford, Saskatchewan.

Mr. Thomas J. Freeman, Receiver and General Manager of the International & Great Northern R. R., has been elected First Vice-President of the Texas & Pacific R. R.

Mr. William S. Turner, until recently Northwestern Manager for W. S. Barstow & Co., of New York City, has opened an office at 1008 Spalding Bldg., Portland, Ore., for the general practice of engineering.

Mr. Charles W. Cade has resigned as Foundry Manager of the Blake & Knowles Steam Pump Works at East Cambridge, Mass., which position he has held for the past eight years, and is now engaged in consulting work.

Dr. Luther William Bahney, M. Am. Inst. M. E., Assistant Professor of Metallurgy at Leland Stanford University, California, has been appointed Assistant Professor of Mining and Metallurgy at Sheffield Scientific School, Yale University.

Mr. C. F. Ford has been appointed Supervisor of the Tie and Timber Department of the Chicago, Rock Island & Pacific Ry. at Chicago, Ill. He will have charge of timber preservation succeeding Dr. Hermann von Schrenk, Assoc. Am. Soc. C. E., who has been assigned to special work.

Mr. A. S. Miller, Assoc. Am. Inst. E. E., President of the Union Electric Light & Power Co., of St. Louis, Mo., and formerly General Manager of the Consolidated Gas Co., of Baltimore, Md., will become a member of the firm of Humphreys & Glasgow, Gas Engineers, of 165 Broadway, New York City, on July 1.

Mr. John S. Burke, Roadmaster of the Dakota Division of the Chicago & Northwestern Ry. at Huron, S. Dak., has resigned after 47 years of continuous service with that road. He entered the employ of the company as a brakeman and has been successively, Conductor, Assistant Division Superintendent and, for over 14 years, Roadmaster.

Mr. O. P. Chamberlain, Chief Engineer of the Chicago & Illinois Western Ry., has been appointed Chief Operating Engineer for all the properties of the Dolese & Shepard Co., Chicago, Ill. He will have supervision of all the outside plants (quarries and stone-crushing works, etc.) and of the Chicago & Illinois Western Ry. His headquarters will be at Gary, Ill.

Mr. C. C. Schneider, Past Pres. Am. Soc. C. E., for many years Chief Engineer of the American Bridge Co., has been appointed the third member of the Board of Engineers, Quebec Bridge, to fill the position left vacant by the resignation of Mr. Charles Macdonald, Past Pres. Am. Soc. C. E. The Board now consists of Mr. E. N. Monsarrat, Chairman, Mr. Ralph Modjeski and Mr. Schneider.

Mr. B. A. Behrend, M. Am. Inst. E. E., has opened an office in the John Hancock Bldg., Boston, Mass., for engineering consultation. Mr. Behrend has been Chief Engineer of the Bullock Electric Manufacturing Co., of Cincinnati, Ohio, of the Electrical Department of the Allis-Chalmers Co., of Milwaukee, Wis., and Advisory Engineer of the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa.

Mr. Edward C. Sherman, M. Am. Soc. C. E., has resigned as Designing Engineer with the Isthmian Canal Commission, having completed the designs for the spillways for the Gatun and Miraflores Lakes, of which he was in charge. Before going to Panama, Mr. Sherman was for some years Division Engineer on the extensive river improvement work at Boston, Mass. He will return to practice in that city as Principal Assistant Engineer with Barrows & Breed, Consulting Engineers, of 6 Beacon St., Boston.

Mr. H. O. Cole, M. Am. Soc. C. E., has been appointed Resident Engineer in charge of lock and dam construction of the Pacific Division of the Panama Canal, succeeding the late W. B. Corse, whose death was noted in Engineering News of April 13, 1911. Mr. Cole is a graduate of West Virginia University of the class of 1898. He was appointed Engineer in Charge of Designing for the Pacific Division in 1908. Later he was appointed Assistant Engineer in Charge of Municipal and Sanitary Improvements for the Pacific Division, including street improvements in the city of Panama.

Mr. George C. Whipple, M. Am. Soc. C. E., of Hazen & Whipple, New York City, has accepted an appointment as Professor of Sanitary Engineering in the Graduate School of Applied Science, at Harvard University, Cambridge, Mass. The appointment will become effective in September, 1911, but will not make necessary the giving up of Mr. Whipple's professional work nor a change of residence. Mr. Whipple graduated from the Massachusetts Institute of Technology, department of civil engineering, in 1889. After being in charge of the Chestnut Hill Biological Laboratory of the Boston Water Department for eight years and director of the Mount Prospect Laboratory of the Brooklyn (later, New York City) Water-Works for seven years, Mr. Whipple entered into his present partnership with Mr. Allen Hazen, M. Am. Soc. C. E., in 1904. Besides his wide range of water-supply and sewage-disposal work in the laboratory, the field and office, Mr. Whipple has written books entitled "The Microscopy of Drinking Water," "Typhoid Fever, Its Causation, Transmission and Prevention," and "The Value of Pure Water." He has been lecturer on water analysis and on other topics at the Massachusetts Institute of Technology and elsewhere and since 1904 has been consulting professor of water-supply and sewage disposal at the Brooklyn Polytechnic Institute.

## Obituary.

James M. McKinlay, Assistant Secretary of the Chicago, Milwaukee & St. Paul Ry. and formerly a Vice-President of that same, died in New York City on May 10. He was 85 years old and entered the service of the Chicago, Milwaukee & St. Paul Ry. in 1868.

Charles G. Warner, former Vice-President of the Missouri Pacific Ry., died at his home in St. Louis, Mo., on May 13. He was born in Zanesville, Ohio, on Dec. 28, 1844. He entered the railway service in 1868 and rose through various clerical positions until in 1880 when he became General Auditor of the Missouri Pacific Ry., and in 1893 he was elected Second Vice-President, which position he held until 1905.

Roswell Emmons Briggs, M. Am. Soc. C. E., died in the city of Mexico on May 4. He was born in New Bedford, Mass., in 1846 and graduated from Rensselaer Polytechnic Institute in 1868, a classmate of Virgil G. Bogue, M. Am. Soc. C. E., Mordecai T. Endicott, President Am. Soc. C. E., and the late L. L. Buck, the famous bridge engineer. Mr. Briggs became a member of the American Society of Civil Engineers in 1869. From that time until his death he practiced his profession in many places and designed and executed much important work, principally in railway location and construction. His first important work was the location and construction of the famous Oroya Ry. in Peru in the early 70's. In 1886 he returned to this same road and made plans and estimates for its completion and extension. In the early 80's he was Chief Engineer of the Mexican Central Ry., and again Chief Engineer of the same road some years later. He was at one time Chief Engineer of the Denver & Rio Grande R. R. Between 1887 and 1890 he was connected with many important engineering works in the United States. For the past ten years he had been engaged in consulting work in Mexico. [Obituary from Mr. F. W. Blackford, M. Am. Soc. C. E., of Mexico City.]

## Engineering Societies.

COMING MEETINGS.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23-25. Annual meeting at New York City. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 23-26. Annual convention at Chicago, Ill. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 23-26. Annual convention at Pittsburg, Pa. Secy., Richard Moldenke, Watchung, N. J.

INTERNATIONAL MASTER BOILERMAKERS' ASSOCIATION.
May 23-26. Annual convention at Omaha, Neb. Secy., H. D. Vought, 62 Liberty St., New York City.

NATIONAL GOOD ROADS ASSOCIATION.
May 23-26. Annual congress at Birmingham, Ala. Secy., Anna M. Grady, Hotel La Salle, Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 29-June 2. Annual convention at New York City. Secy., T. C. Martin, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 30-June 2. Annual convention at Pittsburg, Pa. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 6-10. Annual convention at Glen Summit Springs Hotel, Luzerne Co., Pa. Secy., Joseph Struthers, 29 West 39th St., New York City.

AMERICAN WATER WORKS ASSOCIATION.
June 6-10. Annual convention at Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charleston, S. C.

ENGINEERS' SOCIETY OF PENNSYLVANIA.
June 7-10. Annual meeting at State College, Pa. Secy., E. R. Dasher, P. O. Box 704, Harrisburg, Pa.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 9-10. Annual convention at Seattle, Wash. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 13-16. Annual convention at Chattanooga, Tenn. Secy., Charles W. Hunt, 220 West 57th St., New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-16. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 19-21. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19-23. Annual convention at Boston, Mass. Secy., P. W. Drew, Wisconsin Central Ry., Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 21-24. Semi-annual meeting at Chicago, Ill. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 26-30. Annual convention at Chicago, Ill. Secy., Ralph W. Pope, 33 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 27-29. Annual meeting at Pittsburg, Pa. Secy., H. H. Norris, Cornell University, Ithica, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN CHEMICAL SOCIETY.
June 28-July 1. Annual convention at Indianapolis, Ind. Secy., Charles L. Parsons, Durham, N. C.

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SAN FRANCISCO ASSOCIATION OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.—The 36th regular meeting was held April 21. The secretary announced that the membership has increased to 135. A motion was adopted providing for the appointment of a committee of three to confer with other local engineering societies with the object of having them appoint similar committees. All the committees thus appointed are to form together a general conference committee which will make arrangements to secure an international engineering congress in San Francisco in 1915. The paper of the evening was read by Mr. E. J. Schneider on "The Construction and Design of the Dumbarton Bridge of the Central California Ry."

WESTERN SOCIETY OF ENGINEERS.—The hydraulic, sanitary and municipal section has undertaken to collect and compile information regarding the actual observed run-off or discharge from sewered areas. It is believed that such statistics will prove of value in the designing of sewer systems, sewage pumping plants and sewage purification plants. Engineers having such figures are requested to furnish them to the secretary of the society, at Chicago. City engineers and others are requested to cooperate in the work by installing weirs at the outlets of sewers or providing adequate means for observing the run-off with floats, or by sewage-pump records. The records of maximum storm run-off are of first importance, but the ordinary and dry-weather rates of flow are of value in relation to sewage pumping and purification plants.

AMERICAN ASSOCIATION OF REFRIGERATION.—The second annual meeting was held at the La Salle Hotel, Chicago, on May 11. The most important feature of the meeting was the selection of the place for the next convention of the International Association of Refrigeration; the 1910 convention was held at Vienna, and it was then decided to hold the next in the United States, the place to be settled by the American Association. Both New York and Chicago were nominated, and the latter was finally selected. The association is not a technical one, but deals with refrigerating work and methods in general; it includes representatives of all kinds of concerns interested in the use and manufacture of refrigerating plant and machinery. Officers were elected as follows: President, Wm. J. Rushton, Birmingham, Ala.; Chairman of Executive Committee, Thomas O. Vitter, Milwaukee, Wis.; Secretary, J. F. Nickerson, Chicago.

NATIONAL FIRE PROTECTION ASSOCIATION.—At the 15th annual meeting at the Waldorf-Astoria Hotel in New York City, May 23-25, the following program of addresses and committee reports will be presented:

May 23—Committee reports: Devices and Materials, W. C. Robinson; Automatic Sprinklers, E. P. Boone; Fire Protection Coverings for Window and Door Openings, W. C. Robinson; Conference on Building Code, E. T. Cairns; Fireproof Construction—Including Concrete and Reinforced Concrete, E. T. Cairns; Hose, W. C. Robinson; Hydrants and Valves, H. O. Lacount; Pumps, H. O. Lacount; Private Fire Supplies from Public Mains, E. V. French; Standard Hose Couplings and Hydrant Fittings for Public Fire Service, F. M. Griswold. Address: "The Fire Nation," Charles E. Meek.

May 24—Committee reports: Cold Storage Warehouses, E. P. Boone; Automobile Garages, F. E. Cabot; Common Causes of Fire, Franklin H. Wentworth; State Fire Prevention Associations, W. B. Goodwin; Fire Prevention Ordinances, T. B. Sellers; Signaling Systems, Ralph Sweetland. Addresses: "Private Fire Departments and Fire Drills," R. H. Newbern, Superintendent Insurance Department, Pennsylvania R. R.; "The Fire Waste," Hon. Walter L. Fisher, U. S. Secretary of the Interior.

May 25—Committee reports: High Pressure Fire Service Systems, C. A. Hexamer; Theater Construction and Equipment, F. J. T. Stewart; The Electrical Committee, F. E. Cabot; Electric Railway, Light and Power Properties, C. H. Patton; Explosives and Combustibles, C. A. Hexamer.

AMERICAN FOUNDRYMEN'S ASSOCIATION.—The provisional program for the annual convention at Pittsburg, Pa., May 23-26, has been announced as follows:

May 23—"Economical Insurance for Foundry Properties," S. G. Walker, Providence, R. I.; "Production Costs," Ellsworth M. Taylor, New York City; "The Efficiency Movement in the Foundry," C. E. Knoeppel, New York City; "Foundry Costs," F. E. Webner, New York City; "Why Cost Systems Fail," S. E. Nold, Alliance, Ohio; Presentation of Molding Sand Data of the A. F. A.; Memorandum on the Standard Test Bar for Cast Iron; "Cupola Melting Practice," P. Munnoch; "Cupola Practice," R. H. Palmer, Salem, Ohio; "The Briquetting of Metal Borings," Dr. R. Moldenke, Watchung, N. J.; "Mechanical Charging of Cupolas," G. R. Brandon, Harvey, Ill.; "Progress in Heated Foundry Mixers," J. B. Nau, New York City; "Titanium in Iron Castings," Chas. V. Slocum, Pittsburg, Pa.; "Defective Castings, and How to Handle Them," John M. Perkins, St. Louis, Mo.; "Molding Machine Practice," E. H. Mumford, Plainfield, N. J.; "Machine versus Hand Molding," John Alexander, Philadelphia, Pa.

May 24—"The Permanent Mold," Edgar A. Custer, Philadelphia, Pa.; "The Foundry at Close Range," Benj. D. Fuller, Cleveland, Ohio; "Core Making and Core Machines," Archie M. Loudon, Elmira, N. Y.; "Core Room Practice," F. A. Coleman, Cleveland, Ohio; "Recent Developments in Pyrometry," S. H. Stupakoff, Pittsburg, Pa.; "Recovery of Foundry Waste," S. A. Capron, Westfield, Mass.; "Open Hearth Steel Foundry Practice," R. E. Bull, Granite City, Ill.; "The Manufacture and Annealing of Converter Steel Castings," Bradley Stoughton, New York City; "The Small Open Hearth Furnace for Steel Castings," Walter MacGreggor, Chicago, Ill.; "The Practicability of the Induction Furnace for the Making of Steel Castings," C. H. Von Baur, New York City; "The Electric Furnace for Steel Castings," Dr. P. Heroult, New York City; "Microscopic Structure of Iron and Steel," Prof. Wm. Campbell, New York City; "Titanium in Steel Castings," Chas. V. Slocum, Pittsburg, Pa.; "Vanadium in Iron and Steel Castings," G. L. Norris, Pittsburg, Pa.

May 25—"Foundry Construction," Geo. K. Hooper, New York City; "Electric Motor Drive for Foundries," Brent Wiley, Pittsburg, Pa.; "The Rotary Blower for Cupola Use," R. H. Rice, Schenectady, N. Y.; "The Application of Lifting Magnets for Foundry Work," H. F. Stratton, Cleveland, Ohio; "Pattern Equipment," W. S. Giele, Philadelphia, Pa.; "Titanium in Malleable Castings," C. H. Gale, Pittsburg, Pa.; "The Physical and Chemical Characteristics of Malleable Iron," W. P. Putnam, Detroit, Mich.; "The Equipment of Air Furnaces Using Oil as Fuel," N. W. Best, New York City.

May 26—"Gas Cavities, Shot and Chilled Iron in Iron Castings," Thos. D. West, Cleveland, Ohio; "Manganese and Silicon in the Foundry," A. E. Outerbridge, Jr., Philadelphia, Pa.; Instruction Paper on Phosphorus, H. E. Field, Pittsburg, Pa.; "The Foundry Foremen's Educational Movement," D. O. Wilson, Newark, N. J.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The annual meeting, held in New York on the evening of May 16, was made the occasion of the presentation of the Edison Medal "for meritorious achievement in electrical science" to Mr. F. J. Sprague, of New York. In the course of the exercises, six addresses were made, including the presentation remarks of President D. C. Jackson, and the acceptance by Mr. Sprague. In the presentation address, very brief reference was made to the general historical development of electric science as an introduction to a description of Mr. Sprague's work in developing a commercial electric street railway service and of his inventions which have made possible modern electric high-speed traction. In the address, Mr. Sprague indulged in a few personal reminiscences of his days in the U. S. Navy and the trend of events which turned him from a naval career into electrical engineering. He modestly gave credit for his achievements to the work of his associates and assistants and to the influence of environment and opportunity.

Two historical addresses were delivered; one, "The Development of the Electric Railway," by Mr. W. B. Potter, of Schenectady, and the other, "Electricity in the Navy," by Commander S. S. Robison, Bureau of Steam Engineering, U. S. Navy.

Two noteworthy addresses were made, bearing on the electric railway in modern life. The first of these, entitled "Social Results of the Introduction of the Electric Railway," was by Dr. F. H. Giddings, Professor of Sociology at Columbia University. He stated that the electric railway had not solved the problems of congestion of population in cities, but rather had readjusted the distribution of population and had changed the daily habits of many. It had sifted out those who wanted to be near the center of activities in urban life from those who preferred the country environment. Through the electric railway each kind of human being could more nearly live where he most desired. This was the great contribution of the modern electric railway. It had had another effect, however, that of making the attractions of urban areas more accessible to those who desired to dwell in country environment so that, by the readjustment in progress, the country population was being made up more and more of those who dwelled there because they desired to rather than because they were forced to. Prof. Giddings found that the tendency to increase the power and wealth of some few prominent families and to reduce the status of an increasing number of wage earners had been overcome. The electric railway, he found, tended to maintain the dominance and improve the condition of a middle class, but made impossible too close a standardization of individuals and increased the probability of variations which accompanied progressiveness and true stability. This he believed to be extremely desirable and pointed to a permanent gain for the American people.

The second notable address was "The Relation of Government Control to the Development of Electric Railways and the Electrification of Steam Lines." It was delivered by Dr. G. F. Swain, Professor of Civil Engineering at Harvard University. He believed that the country stood on the eve of a great step, a change in methods of transportation, by which electricity would be generally substituted for steam. He believed that the time was coming when the bulk of the freight and passenger traffic of the country would be electrically hauled. He stated his belief also that the change would be so far-reaching and would involve so many economic problems, rather than engineering ones, that it would be necessary to proceed very slowly. At first, he pointed out, only partial operation might be expected as at congested terminals. Only when the work of electrification was completed for all the traffic over long stretches, such as single engine runs, could real economy be secured. In early and partial developments there was almost undiminished steam traffic cost, plus the heavy investment charges and normal operating expenses of the electric service. He asked and answered the question, "What is government regulation in this cases?" He held that there was no q uestion about the wisdom of government supervision of any public utility, but that there was a question of proper extent of control. This extent of control, he held, depended on the degree of necessity of the service rendered. Where the service was a luxury, the government should not interfere. The public was ever to be protected only to see that it secured good service at a reasonable price. Freedom for initiative, on the part of the owners of the public utility, was to be preserved, and the desire for gain was not to be smothered. Prof. Swain held that electrical operation of steam roads is now a luxury and not a necessity, since the traffic can be handled as adequately, as safely and as economically by steam as by electricity. The Government should hold a policy of non-interference in transformation from steam to electric traction, that the progress might be unhampered and might proceed along natural, rather than forced lines.

As this meeting was the annual one of the Institute the tellers' report on the election of officers was presented. It was announced that the President-elect was Mr. Gano Dunn, Chief Engineer of the Crocker-Wheeler Co., Ampere, N. J. As Vice-Presidents, Messrs. D. B. Rushmore, C. W. Stone and W. G. Carlton were declared elected. Four new Managers were elected: Messrs. F. S. Hunting, F. Osgood, N. W. Storer and W. S. Lee.